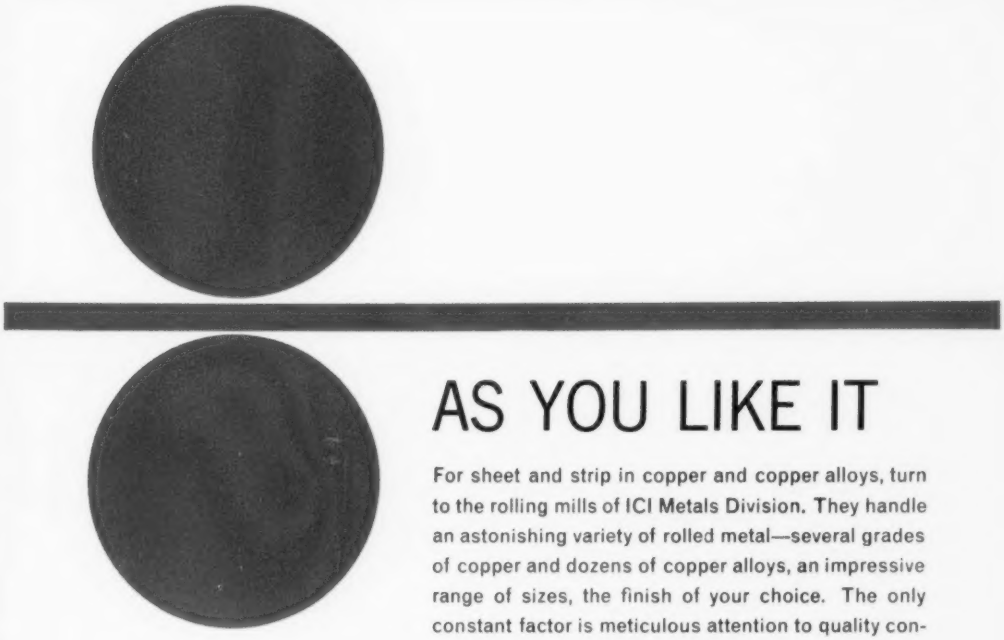
12 MAY 1961

METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS



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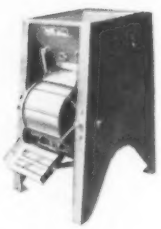

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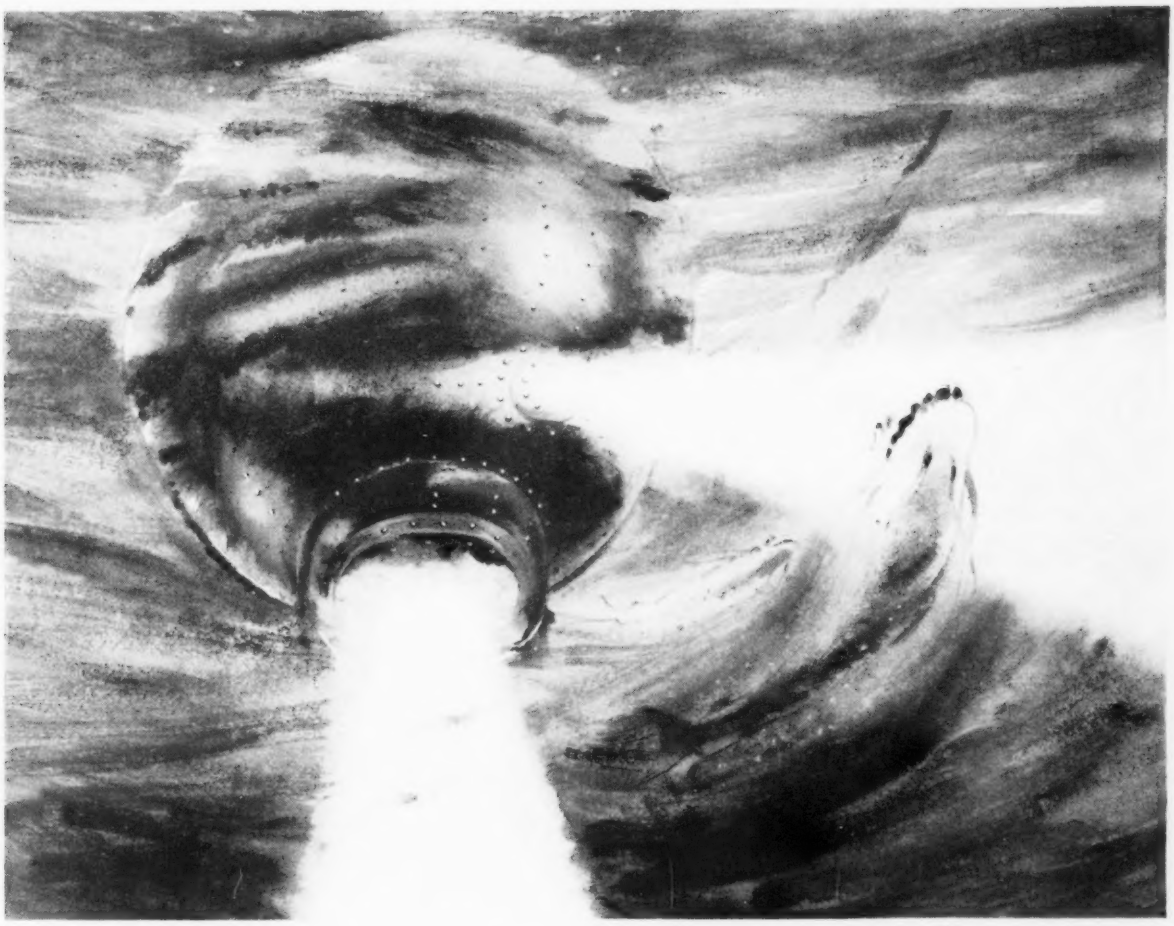

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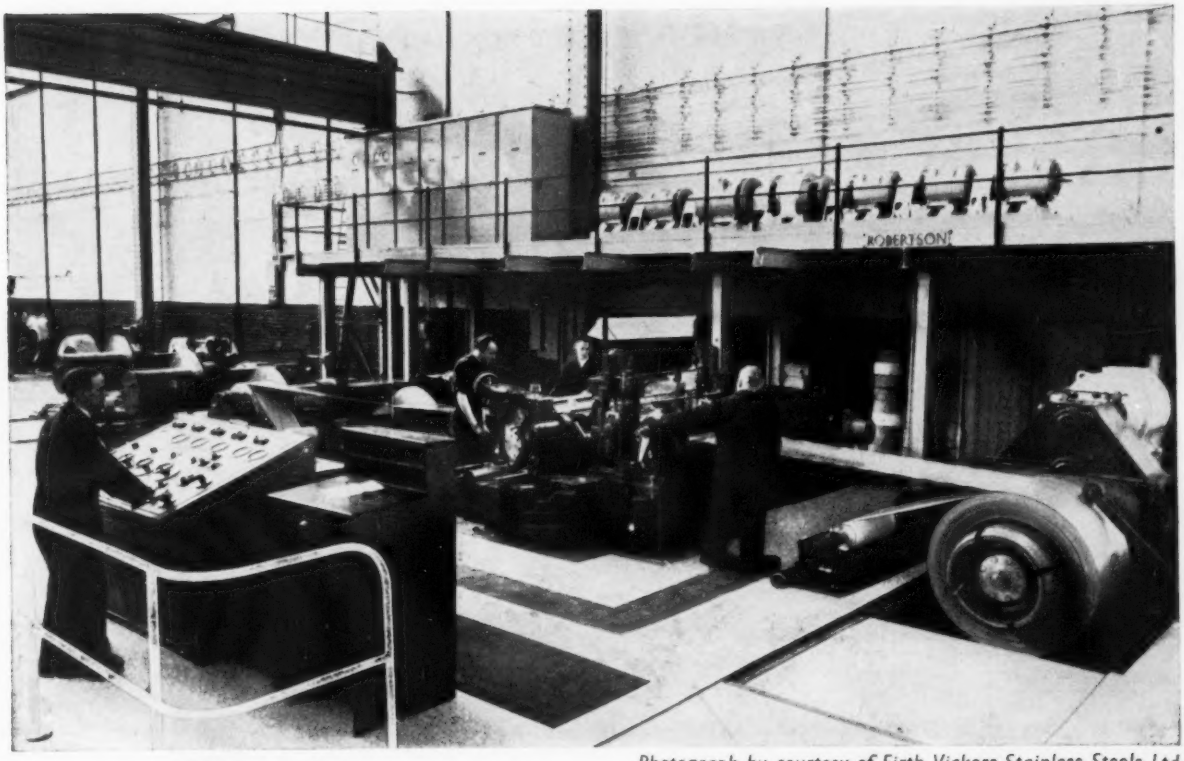

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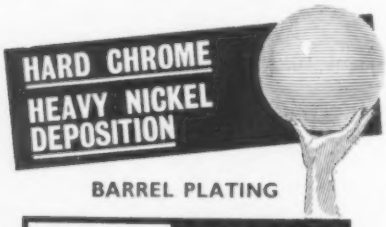

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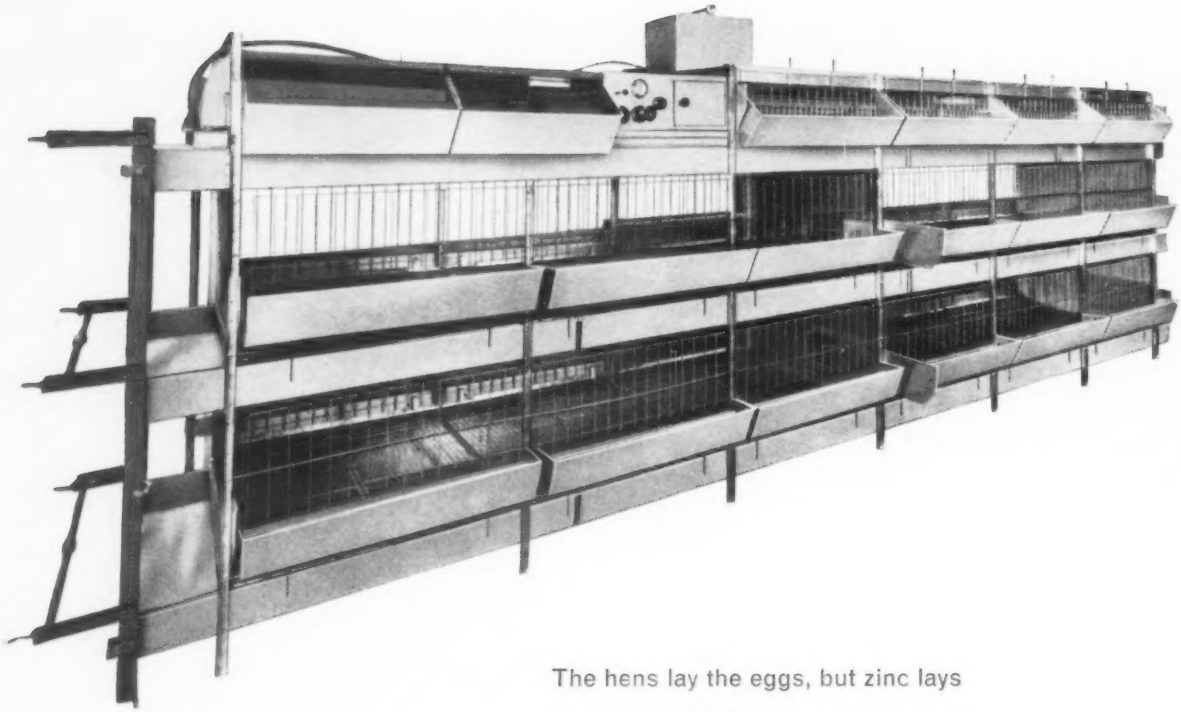

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METAL INDUSTRY

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Research At The N.P.L.

PIONEERING research in a number of important branches of physics is reported in the National Physical Laboratory's report for 1960, published this week. They include work on ultra high pressures, physics of high polymers, autonomics, and noise measurement and control. Proposals for two new research programmes have also arisen during the year. One is for a research and development programme on high speed digital computers to be carried out as a co-operative effort by Government laboratories and industry. The second is a proposal for a research reactor, to be sited at Teddington, for standards work and for basic research by both the N.P.L. and the National Chemical Laboratory.

In that section of the report dealing with non-ferrous metals it is stated that in the investigations of the possibilities of increasing the use of niobium in alloys for high-temperature applications, more extensive tests have confirmed that the resistance to both creep and recrystallization of a 90:10 nickel-chromium alloy after various amounts of cold work is increased more by additions of niobium than by equal titanium additions. It is estimated that the niobium-bearing material would have a life of some years at 600°C. without recrystallizing and it is thought that alloys of this kind may have advantages in applications where resistance to repeated plastic deformation is part of the essential requirements.

Turning to titanium, the report states that the tensile properties of a number of titanium-aluminium alloys at room temperature and −196°C. have been determined in order to follow the decrease in ductility with increase in aluminium content up to about 10 per cent. It is known that brittleness develops with time during heat-treatment at about 600°C. when the aluminium content exceeds about 8 per cent. Alloys of this composition are also difficult to hot work, so that considerable delay has been experienced in obtaining an extruded 10 per cent aluminium alloy. No brittleness has been produced in alloys containing up to 7½ per cent aluminium on heat-treating at 600°C., but the brittleness is well developed in the alloy containing 10 per cent of aluminium. The embrittled alloy decreases in tensile strength as the temperature falls from room temperature to −196°C. and the elongation and reduction of area at fracture decrease to zero. This type of behaviour is of great interest, since it has hitherto been observed principally in iron alloys which have been rendered susceptible to intercrystalline embrittlement by the introduction of an impurity.

An investigation of recrystallization and grain growth in a titanium-10 per cent molybdenum alloy using the optical microscope has also been carried out. A modified absorption apparatus has been constructed in order to reduce contamination to a minimum during the absorption process, and so ensure that the characteristics of the niobium-hydrogen alloys are determined solely by hydrogen content. In the same section of the report it is stated that the thermochemical work on metallic phases is being continued with the emphasis on its application to the evaluation of phase boundaries at temperatures where the conventional methods fail. The activities in the chromium-molybdenum solid solutions have been obtained, at 1,200°C., from the chromium pressures determined by combining Knudsen's effusion technique with tracer analysis, and have been used to estimate the extents of the miscibility and the solidus-liquidus gaps. A miscibility gap has not hitherto been reported in this system, but some suggestions that one may exist have been made. Experiments are now in hand to show whether the gap predicted from the thermodynamic work exists in fact.

Out of the MELTING POT

Under Control IN view of the current trend towards the exercise of closer and still closer control over the microstructural characteristics and constitution of metals and alloys, developments in that direction in connection with internally oxidation-hardened alloys were to be expected. As is known, alloys that can be hardened by internal oxidation consist of a non-oxidizable solvent metal through which oxygen can diffuse, and a solute metal which forms stable oxides. Typical examples of such alloys are silver containing 0·3 per cent magnesium and copper containing 0·25 per cent aluminium or 0·25 per cent beryllium. Heating such alloys in an oxidizing atmosphere results in the diffusion of oxygen into the alloy and the formation, by oxidation of the solute metal, of very small refractory oxide particles in the matrix of the solvent metal. The formation of these refractory oxide particles produces a considerable increase in strength. However, the oxidation hardened metal tends to suffer from intergranular brittleness, presumably due to a relatively high concentration of oxide in the grain boundaries of the alloy. Another disadvantage of this form of oxidation hardening is that its use is limited to products of relatively thin section, because the rate of diffusion of oxygen is very low and the time required for internal oxidation increases as the square of the diameter or thickness. Greater control of the oxidation hardening process has now been achieved by introducing it at an earlier stage of the manufacturing process. Instead of treating the finished parts made of an oxidation hardening alloy, the oxidation hardening alloy is first produced in the form of a powder, which is then oxidation hardened. The oxidation hardened powder is then converted into the required products by known methods (pressing and sintering, hot pressing, hot extrusion), with subsequent cold working, e.g. rolling, etc., as required. The hot working should effect a plastic deformation of between 50 and 75 per cent in cross-sectional area in order to ensure coalescence of the internally oxidized powder particles. In this way, parts of large cross-section can be obtained, and at the same time the objectionable brittleness of internally oxidized alloys is avoided.

Neglected CONCENTRATION on achieving the optimum in any process is, of course, praiseworthy, but at the same time carries with it the risk of neglect or oversight of interesting effects observable under conditions that differ considerably from the optimum. Many such effects may well be awaiting discovery on the sidelines, as it were, of familiar production processes. Even if no such effects are discovered, the sidelines themselves are worth investigating if only for the challenging reason that they are there. Take the various processes of plastically working metals, for example. While production concentrates on maximum output, achieved by optimum combinations of rates and degrees of deformation achieved by the application of enormous forces in, for example, rolling, extrusion, drawing and, more recently, explosive forming, the purer research worker might well on occasion depart from the optimum to study what happens at the sidelines. What happens, for example, if metal is rolled or drawn at very low speeds? What happens when metal is rolled or drawn at normal speeds but reduced by very small increments in a long succession of passes? What, for example, would be the behaviour of a tensile test piece if it were subjected to a succession of loadings each capable of producing a very small permanent set? These thoughts and questions have been inspired by a recent account of an unexpected discovery made in connection with the ball milling process applied to the grinding of a cobalt-copper-aluminium-nobium magnet alloy. The cast and crushed alloy was ground to powder in a small ball mill. Experiments in which balls of different diameter, different ball-to-charge ratios, etc., were used, showed up the occurrence of a constant point of inflection on the grain size curves obtained under conditions other than the optimum (relatively small ball diameters). The suggestion that this effect was due to self-grinding of the charge was confirmed by an experiment in which a charge of the crushed alloy was milled without balls, than which nothing could be more remote from the optimum.

All The Way AN important advantage of the method of radioactive tracers, applied to studying wear, is the ease with which the subsequent movements of the products of wear can be followed both qualitatively and quantitatively. In studying the wear of a wire drawing die, for example, the radioactive tracer method will permit not only the determination of the total wear, which, after all, could have been determined without much difficulty by conventional means, but can also show what happens to the material that has been worn away. Some of this material is carried away on the wire and some by the lubricant fed to the entry side of the drawing die. In drawing copper wire through a die of cobalt-bonded tungsten carbide, with a 2 per cent soap solution-oil emulsion as the lubricant, it was found that the proportion of debris carried away on the wire increased with drawing speed, e.g. from 75 per cent at 30 m/min. to 92 per cent at 490 m/min., the remainder being carried away in the lubricant. This behaviour is probably connected with the increase in the amount of lubricant passing through the die on the wire with increase in drawing speed which, in turn, is in accord with the reduction of the specific die wear that occurs as the speed of drawing is raised. Although some of the products of wear are only very loosely held on the wire (this depending to some extent on the nature of the lubricant), only a relatively small proportion (4-8 per cent) of the die material carried away on the wire is subsequently transferred to the drum. Likewise, in the subsequent drawing of the wire through a smaller die, about 85 per cent of the debris from the previous die is carried through on the wire, and only about 12 per cent is removed by the lubricant. In a series of draws, only about 2·5 per cent of the debris carried on the wire is removed in ways other than removal by lubricant. A study of the debris on the wire by autoradiography showed that it comprised a fine uniformly distributed fraction, probably cobalt, discrete grains of tungsten carbide, and discrete groups of grains. As with so many other radioactive tracer studies, the practical significance of all these interesting findings remains to be assessed.

Skimmer

Miscellaneous articles chemically polished in Phosbrite 183 and 184

Chemical Polishing

ITS APPLICATION TO ALUMINIUM AND COPPER ALLOYS

By P. F. WALMSLEY

(*Sales Manager, Metal Treatment Department, Albright and Wilson (Mfg.) Ltd.*)

APPLICATION of chemical polishing techniques as an aid to the economical production of decorative finishes has increased very considerably during the last few years. During a period of full employment it is relatively easy for the skilled artisan to find cleaner work in more pleasant surroundings than those of the typical polishing shop. The manufacturer, therefore, has had to pay ever-increasingly high wages to the manual polisher. There is considerable economic pressure leading him to find alternative ways of producing the bright finishes which the present-day consumer demands.

Aluminium was the first metal to be chemically polished on an industrial scale. In the early days, a brightening process was found to be a necessary preliminary to anodizing. An alkaline electrolyte was developed by British Aluminium Co. under the name "Brytal" for use on reflectors made from super-purity material. Simple phosphoric acid mixtures were used to brighten the lower grades of aluminium. Without the brightening stage, polished anodized aluminium often looks dull and unattractive. If colour-anodized, the article may have a patchy appearance.

The phosphoric acid type of mixture has since been developed very considerably, and since 1956 Phosbrite 159 has been used more and more for chemical polishing, thus eliminating mechanical polishing. Phosbrite 159 has levelling properties which remove minor surface imperfections and scratches. The brilliance or specular reflectivity of the surface so treated has made it possible to use aluminium in a wide variety of decorative applications where the highest standards are demanded by critical consumers.

The versatility of the process makes it particularly attractive to the jobbing anodizing outworker. This point may be well illustrated by the case of a large company who regularly polish aluminium wheel discs, radiator grilles, curtain rails and large numbers of small pressings like ashtrays in their 16 ft. long Phosbrite tank, with which is associated the appropriate anodizing capacity. The same bath is used for brightening super purity reflectors, after mechanical polishing, whilst a small bath is always available for special high quality work.

The layout of this plant is not, as it happens, typical. Figs. 1 and 2 show how the hot rinse tank is placed behind the polishing tank, and these are both served by a common exhaust. Fume extraction is essential to remove the nitric acid fumes which are evolved during polishing. Where space is available it is usually more convenient to

Fig. 1—Dipping washing machine drums in the largest Phosbrite tank in the country, at the Birmingham works of Haynes, Ford and Elliott Ltd.

place polishing and rinse tanks in line with the exhaust slots running the length of the two tanks, as shown in Figs. 3 and 4.

Phosbrite 159 is contained in a tank made from molybdenum-bearing austenitic stainless steel. Care has to be taken that the welds are sound and the correct filler rod is used, for a leak will lead to a loss of acid profitable only to the manufacturer of the polishing solution.

The bath operates at 100-110°C. Heating may be by stainless steel steam coils, which will give years of service provided welds are not immersed and faulty heat-treatment during manufacture has not led to inter-granular corrosion. It is more common for the smaller operator to use silicon-sheathed electric immersion heaters. These normally give satisfactory service, but it is occasionally necessary to remove deposits from the surface.

Fume extraction equipment is made from rigid P.V.C., and now that chemical polishing and anodizing plants, like other factories, are moving away from the traditional "industrial" areas, it is becoming increasingly necessary to absorb the acid fumes in a scrubbing tower with an alkaline solution.

Chemical polishing usually takes from 2-3 min. If brightening only is required, i.e on work that has first received a high degree of mechanical polish, the time of immersion is reduced to between 30-60 sec. As there are no problems of current distribution with a non-electrolytic process, the work can be racked in the simplest way that is convenient; small articles are often treated in stainless steel baskets. After polishing, the work is transferred to a clean hot water rinse tank, usually made from stainless steel. Desmudging in cold 50 per cent nitric acid and a water rinse complete the process. Anodizing normally follows but, where this is not done, a hot water rinse will aid stain-free drying.

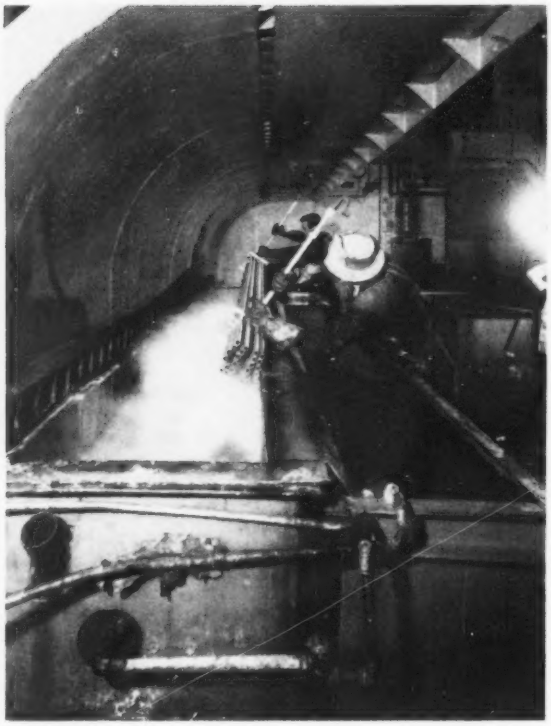
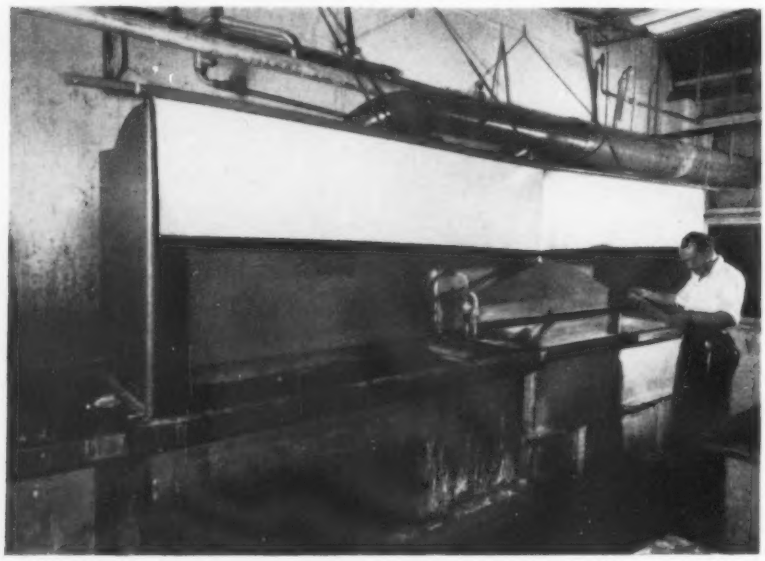


Fig. 2—End view of the Phosbrite tank at Haynes, Ford and Elliott Ltd. showing the operators immersing decorative lighting tubes

The process is a very simple one to control. It is only necessary to make regular daily additions of Phosbrite to replace inevitable losses by carry-over and evaporation. Nitric acid must be maintained at the recommended level, as indicated by a simple analytical procedure.

A detailed study of operating conditions at the large anodizing company mentioned previously led to the development of a routine involving water additions to maintain the bath specific gravity at the correct figure. This prevents crystallization of aluminium salts and under these conditions a bath can be operated virtually indefinitely without having to be discarded and replaced. At this particular plant, daily replenishment is made from a 1,000-gal. stainless steel storage vessel, which is refilled from bulk tanker delivery, thus saving handling and effecting economies in price.

Fig. 3—Chemical polishing plant at Acorn Anodizing Ltd. of Hanwell. The bath for Phosbrite 159 has a capacity of 300 gal. The rinse tank is on the left



There are still many manufacturers who prefer to have their metal finishing done by an outworker, and the vast majority of decorative anodizers today operate a Phosbrite 159 bath in order to help satisfy the increasing demand for this finish. Reduction, and, in some cases, elimination, of mechanical polishing have led to savings by the anodizer and lower costs to his customer.

Aluminium manufacturers soon realized the possibilities of the new process. The high cost of super-purity aluminium limited its use on mass-produced articles. Phosbrite 159, however, produces a finish on alloy based on lower purity aluminium of a standard to satisfy the most exacting demands. Alloys based on aluminium of 99·7-99·8 per cent purity containing ½-1 per cent magnesium, have now been developed: these lose brightness only to a negligible extent when anodized to present-day standards. Rolling techniques have been improved to produce sheet with a uniform clean surface which needs no further mechanical finishing before chemical polishing. Typical alloys are B.A.330, Noral F57S

Fig. 4—Close up of polishing bath at Acorn Anodizing Ltd.

and Birmetals BB.17. Impalco and High Duty Alloys offer similar materials.

Efforts of the suppliers to produce first class anodizing quality aluminium are wasted if the article concerned is damaged during manufacture. Progressive companies are now reaping the rewards of careful attention to press design and handling. The need to reduce handling to a minimum to avoid surface damage has led many large manufacturers to install their own chemical polishing plant.

It is the automobile industry which has made the most spectacular increase in the use of decorative aluminium in recent years. At one aluminium fabricating works in Birmingham, a high proportion of the work is the manufacture of radiator grilles, headlamp housings and similar items of car trim (Fig. 5). Again, a combination of careful planning, specially developed high-purity aluminium and chemical polishing has made it possible to produce a first class finish with a minimum expenditure on mechanical polishing. The company makes large reflectors from the same alloy, and, in fact, it is now becoming exceptional to use the more expensive super-purity grades even in this application.

So great has been the demand for bright aluminium, particularly for car trim, that this company is at present installing a fully-automatic chemical polishing and anodizing plant in their new works. This will be the first of its kind in the country.

About two years ago, a well known firm manufacturing washing machines, dryers and suction cleaners, entirely eliminated the need for mechanically polishing aluminium switch plates and other bright pressings which add so much to sales appeal. Their 200 gal. plant, situated just outside the main factory, chemically polishes a variety of such articles typified in Fig. 6.

Another company, producing tea trolleys and similar articles, have had a Phosbrite plant for several years. At this works, not only have polishing costs been cut down, but the brilliant finish gives gold anodized articles a characteristically "solid" appearance. The plant is unusual in that air-agitation is employed. This may be an advantage for these more unwieldy articles, but mechanical (or manual) agitation is usually preferable since air-agitation considerably increases nitric acid consumption.

Smaller items, such as costume jewellery, can be treated by this process in quite a small plant. One firm of metal spinners chemically polish saucepan lids and kettles before colour anodizing. Gold anodized bracelets, tea trolleys and cigarette cases, blue, red and "copper" anodized saucpan lids and ashtrays nowadays possess a jewel-like finish far superior to the colour anodizing previously produced.

For some applications, an alternative finish is becoming more generally used. This is produced using Phosbrite 155 or 156, treatment in which produces a lustrous finish having a high total reflectivity with low specular component. For instance, on vacuum cleaner straight tubes, the "mirror" bright finish from Phosbrite 159 would tend to highlight surface defects resulting from the forming operation; use of the alternative process eliminates this effect. This type of solution has to be contained in a lead-lined tank: stainless steel is unsuitable. It is attractive to many operators because, as it does not contain nitric acid, fume extraction is often unnecessary. The same finish is often used on reflectors, where it is desired to spread diffuse light over a maximum area.

Although these developments have encouraged the use of more and more aluminium to replace the more commonly used bright nickel chromium plated steel or brass, there are still many places where physical requirements dictate otherwise. Unfortunately, attempts to chemically polish steel or zinc alloys have so far met with very limited success.

Brass and other copper alloys can, however, be successfully chemically polished using a type of solution

Fig. 5—The Triumph TR3 radiator grille, made from 99·7 per cent purity aluminium, is polished in Phosbrite 159

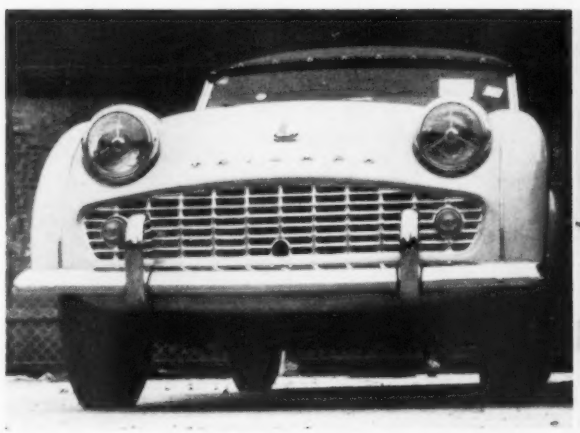
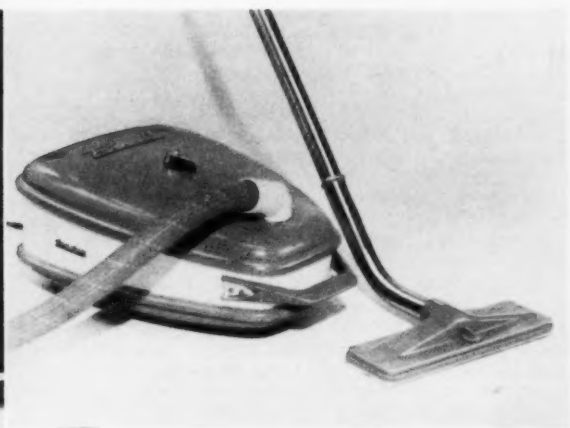


Fig. 6—The Parnall "Tenten" domestic vacuum cleaner of which some of the fittings are chemically polished



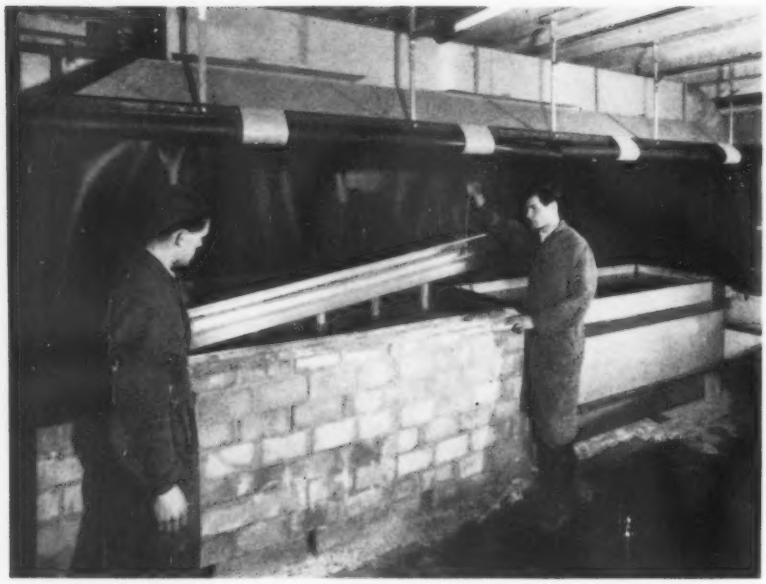


Fig. 7—Light reflector, 5ft. in length, being immersed in the chemical polishing tank at B. T. Anodizing and Plating Co. Ltd. at Fulham

developed in this country about two years ago. When combined with one of the modern levelling bright nickel plating processes, chemical polishing can lead to important economies.

There are many cases where it is possible to use the single-phase alpha brasses in manufacture, and where excellent results and consequent cost savings are being obtained. Plant is usually installed by the manufacturer or outworker who wishes to treat a mass-produced article designed with chemical polishing in mind.

Various brass refrigerator fittings are chemically polished by one company in their 200 gal. tank. The polishing tank, which is manufactured from stainless steel and equipped with PVC extraction exactly like the Phosbrite 159 tank, is heated to 60°-70° C. with silica-sheathed immersion heaters. After 2 min. immersion, work is rinsed thoroughly in cold water and plated.

Another company installed the process to polish brass television aerials. These are afterwards bright nickel and gold plated. It is very difficult to polish this type of article by any other method. The same bath is now being used on brass speedometer and other instrument dials prior to bright nickel chrome plating and a variety of other miscellaneous brass and copper components for various customers.

Other companies have found it possible to eliminate mechanical polishing by using the process on flexible brass hose used for bright nickel chrome plated bathroom fittings. Another application is in the chemical polishing of brass tea strainers before bright nickel chrome plating. It should be noted that it is sometimes found necessary in these cases to follow the cold rinse with an immersion in arsenious chloride solution before bright nickel plating.

Similar solutions can be used on gilding metal, nickel silver and beryllium copper. Electrical contacts made from beryllium copper are being economically polished and deburred with Phosbrite 184 by several companies. A recent application is for chemical polishing nickel silver pencils prior to bright silver plating. Cutlery and costume jewellery manufacturers are also developing applications.

Applied to copper alloys, chemical polishing will, no doubt, be used even more extensively in the future. Development in this field has been slower than with aluminium since best results are obtained only on fine grain single phase alloys, and it has not always been possible to obtain these. However, several companies, notably Ever-Ready Co. (Gt. Britain), Alfred Case, and I.C.I., who offer the special "Kuniform" range, are now able to supply brasses which respond admirably to chemical polishing.

Rising labour costs are making chemical polishing an ever-increasingly useful process to industry. Now that manufacturers are producing sheet metal, particularly aluminium and brass, specially for the purpose, it has become very much easier to design articles which must have a bright finish with chemical polishing in mind. This often involves special attention to tool design and careful handling, but such trouble is amply repaid by the financial savings which result.

Acknowledgments are due to the following firms for supplying information upon which this article is based: Acorn Anodizing Co. Ltd., Electrolux Ltd., Freevy Ltd., Haynes, Ford and Elliott Ltd., Liver Plating Co. Ltd., London Aluminium Co. Ltd., Midland Metal Spinners Ltd., Parnall (Yate) Ltd., and Woodmet Ltd..

High Conductivity Springs

A NICKEL-SILICON-COPPER alloy that fulfils the need for a spring material with mechanical properties at least equal to those of the conventional phosphor bronzes and brasses, but with appreciably higher electrical conductivity, has been developed by Johnson, Matthey and Co. Ltd.

Because of its exceptionally high electrical conductivity, 40-45 per cent I.A.C.S., the new alloy, Mallory 53, enables springs of small section to carry appreciably larger currents than when made in phosphor bronze. Advantage can be taken of this characteristic to increase the current rating of existing designs of springs.

All spring-forming operations can be applied to Mallory 53 after heat-treatment, and hence the alloy is supplied in the precipitation hardened condition, requiring no further heat-treatment by the user.

A data sheet, 1300:332, giving details of the characteristics of the alloy and the forms in which it is supplied, is available on request to the company's head office at 73-83 Hatton Garden, London, E.C.1.

Load Measurement

ACCURATE elastic devices are now being very extensively used as weighing units in industry, ranging from portable units for weighing aircraft, to built-in units for weighing large storage hoppers and silos.

The latest addition to the N.P.L. series "Notes on Applied Science", deals with the measurement of load by elastic devices. The Note defines the technical unit of force used when elastic devices are calibrated, and outlines the facilities available at N.P.L. for their calibration.

Descriptions and comments about their use are given for the more common types of elastic devices such as proving rings, standardizing boxes, hydrostatic load capsules and electrical resistance strain gauge load cells.

Two final sections deal with temperature corrections and methods of plotting the calibration results graphically, thus permitting interpolation between calibration loads and the accurate transfer from one system of units of force to another.

The booklet, "Measurement of Load by Elastic Devices", is published by H.M. Stationery Office, for D.S.I.R., at 3s. (U.S.A. 54 cents).

TYPES OF COMPACTION — SINTERING — GENERAL APPLICATIONS — FUTURE TRENDS

Powder Metallurgy - A Survey

By I. JENKINS, D.Sc., F.I.M.

(*Concluded from* METAL INDUSTRY, 5 *May*, 1961)

DURING compaction, there is a resistance to flow due to frictional forces between the particles of powder and between the powder and the die walls. The transmission of an external pressure through a body of fine powder is only possible over short distances, so that the production of compacts of uniform density is difficult.

When a compact is prepared by pressing powder in only one direction the density of the compact is not uniform, the highest density being near to the surface in contact with the moving punch. Improved pressure distribution can be obtained by pressing the powder in two opposite directions simultaneously. Density maxima are then obtained at both the top and bottom of the compact with the lowest density in the centre. If the required component has a large variation in thickness in the pressing direction, then during compaction the movement of the punch at points corresponding to the variations in thickness needs to be different. Using a multiple punch, the compression can be controlled so that the required shape is obtained.

The size and shape of a compact are limited by a number of factors. High pressures are usually required and, therefore, the capacity of the press limits the maximum area of cross-section of the compact. In addition, the maximum length in the pressing direction should be related to the area of cross-section; if the ratio of the length to the width of a compact of square cross-section is greater than one, then the difference in density between the top and bottom of the compact will be greater than 10 per cent if the compaction is carried out in one direction only.

Within certain limits the shape of the component is also restricted. Lateral projections can be catered for but an undercut must be obtained by a subsequent machining operation. The formation of holes in the direction of pressing presents no difficulties, but holes in any other direction must be made at a later stage. Abrupt changes in section are to be avoided, as also are thin sections and designs which require feather edges on either the compact itself or on the parts of the die.

Pressing Techniques

The majority of the pressing carried out in practice uses mechanically or hydraulically operated presses, but other techniques may be used in special cases, all aimed at producing a compact more uniformly pressed. In recent years, particular attention has been paid to the development of continuous compaction processes. For example, metal sheet and rod are produced continuously from metal powder by rolling or by extrusion. Rods of hard, brittle materials such as carbides can be produced by extrusion, usually in metal sheaths, whilst rolling of strip direct from powder is used in the production of copper, nickel, iron and some of their alloys.

Pressure can be applied to a body more uniformly by isostatic means (Fig. 13), and complex shapes are now being produced in this way. The metal powder may be contained in a flexible mould, such as latex, and subjected to isostatic pressure by immersion in a fluid such as oil. Alternatively, the powder may be contained in a mould made of a reversible gel, such as polyvinyl chloride, and subjected to pressure from a plunger in a closed die. The gel is dimensionally stable, deforming under pressure but behaving in compression substantially as though it were a liquid, i.e. it returns to its original shape and dimensions on the release of pressure.

A further technique, as yet not fully developed, is that of slip casting. In this process a slurry of the powder is made with a suitable liquid and is poured into a mould of the required shape, the liquid of the slurry being absorbed by the material of the mould. In this way, a powder form is built up on the surface of the mould and grows in thickness as the liquid constituent is absorbed by the mould wall.

Sintering

The sintering of metal powders to form dense compacts may be considered to take place in two stages, namely, the welding of individual particles, and the elimination of porosity. When any two clean surfaces are brought intimately into contact, welding will take place at the point of contact, even at room temperature, and at higher temperatures this welding is facilitated by the removal of obstructing surface films and by diffusion. During the pressing operation, the area of contact between the powder particles is increased by deformation, which helps to destroy the continuity of surface films.

The driving force behind the sintering process is the energy associated with the surface of the powder particles. The equilibrium state of any system is that of lowest energy and in a mass of powder the large total surface energy provides the force aiming to reduce the total internal surface area. This means that the size of pores tends to decrease and pores should ultimately disappear completely provided that there is no opposing force. One of the sources of an opposing force is gas, which accumulates in the pores when they are completely isolated, and when this occurs, sintering in a vacuum will often effect a further densification.

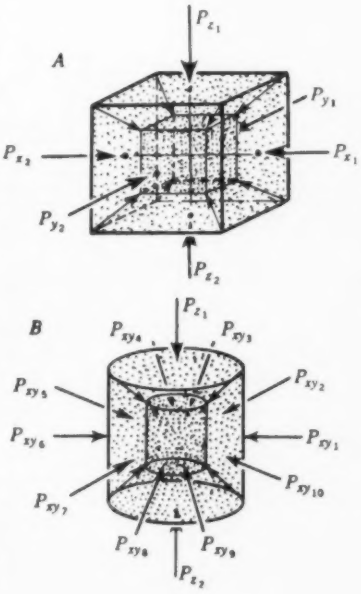


Fig. 13—Isostatic pressing. At left: three-dimensional compaction (schematic): A, cube; B, cylinder. At right: hydrostatic pressure apparatus for compacting metal powders (according to Skaupy)

Increasing the sintering temperature will increase the rate of sintering, and it is general practice to use the highest temperature, short of the melting point, which is economically practicable.

Reference has already been made to sintering of alloys of widely differing melting points such that the one of lower melting point melts at the sintering temperature. This molten phase may be of a temporary nature, alloying with the solid phase to produce a new solid alloy, or it may remain molten throughout the sintering process, dissolving or not some of the solid phase. In either case, the presence of a liquid phase accelerates the sintering process, removing films from the surface of the solid particles and expelling gases trapped in the body. Fully dense bodies can be obtained. The percentage of liquid phase permitted is of the order of 15 per cent, since if it is greater than this, the bodies will distort or even collapse completely during sintering.

In the infiltration process, a sintered skeleton of a high melting point metal is allowed to absorb a molten metal of lower melting point. In this way, it is possible to combine metals of widely differing characteristics which may not normally alloy, e.g. silver-tungsten and copper-tungsten for electrical contacts and welding electrodes; copper-graphite for commutator brushes; and iron-copper alloys for compressor turbine blading.

The pressing and sintering operations may be combined by compacting at an elevated temperature, usually in graphite moulds. Plastic deformation and sintering will take place simultaneously, giving a product having little or no porosity. "Hot pressing", as it is called, has a number of advantages, but is not used very widely because of limitations in die material, of die wear, and of the need to prevent oxidation of the powder particles. Obviously, the use of graphite dies limits the process to metals which do not react extensively with carbon.

The rate of sintering will be increased by any process which will increase the mobility of the metal atoms, and the term "activated sintering" has been applied to processes in which this is claimed to be achieved by chemical means. For example, the reduction of oxide films during sintering facilitates the formation of metal to metal bonding; halogens are also used for the same purpose.

Many of the furnaces used for sintering are the same as those used in general heat-treatment practice, and both gas-fired and electric furnaces of the batch and continuous types are used. They are normally supplied with a special atmosphere generator. In the mass production of small sintered parts, continuous furnaces are normally used, in which the compacts are conveyed through the furnace on a moving belt or in boats which are pushed from one end. The sintered parts are delivered at the exit end of the furnace after passing through a cooling zone. Sintering *in vacuo* is always carried out in batch-type furnaces. Heating by passing an electric current directly through pressed bars of powder is used for the very high melting point metals such as tungsten, tantalum and molybdenum, etc., in an atmosphere of pure hydrogen or in a vacuum. More recently, high frequency induction heating has been employed, usually in a vacuum, for the sintering of certain types of carbides.

General Applications

High Density Components. For general engineering components, powder metallurgy has to compete on an economic basis with established techniques, and applications are often further limited by inferior mechanical properties of the product as compared with wrought materials, the high tooling and raw material costs and by design considerations. In general, therefore, powder metallurgy finds major application where its use shows some technical advantage or when the quantities required lead to a mass production process which, economically, is attractive.

Magnetic Applications. For magnetic applications, the sintered product holds technical advantages in that both magnetically hard and magnetically soft materials possessing specific magnetic properties are produced. These include the permanent magnet alloys, which are difficult to machine and which can be made as finished magnets by sintering. More recently, elongated pure iron powder, in which each particle is of the order of 200 Angstroms in size has been produced electrolytically. When bonded with tin or lead, the powder yields permanent magnets with an energy content comparable with the Alnico types. High purity nickel-iron base alloys for soft magnetic purposes are also produced by sintering. The particular significance of this latter application is the extent to which specific magnetic properties such as permeability and losses can be reproduced within extremely narrow limits.

Nickel-iron and nickel-cobalt-iron alloys for sealing to glass and ceramics are produced similarly. In this way, the expansion characteristics of the alloys can be held to within very narrow limits.

Ferrous Alloys. A variety of structural parts is made from sintered iron and sintered steel (Fig. 14). Iron, as sintered, possesses low mechanical strength and high porosity, but both these disadvantages can be eliminated to a large extent either by re-pressing and re-sintering to increase the density; by alloying; by carburizing; or by filling up the pores with a metal of lower melting point, such as copper.

Non-Ferrous Alloys. High density non-ferrous materials produced by powder metallurgy include tungsten,

Fig. 14—Sintered iron and steel parts

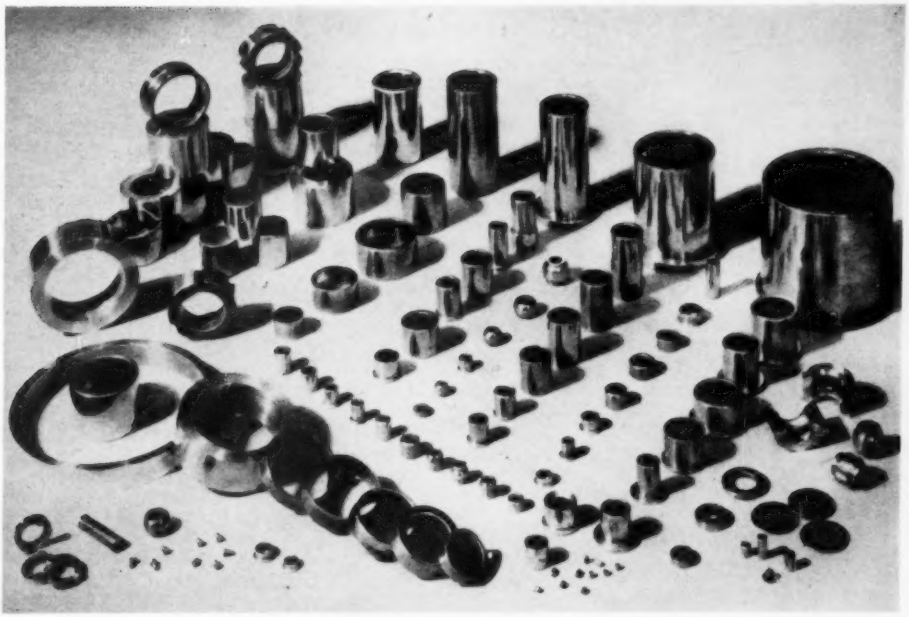


Fig. 15—Sintered porous metal bearings [Courtesy Bound Brook Bearings Ltd.

molybdenum, and tantalum, which are produced by sintering bars of pressed powder at temperatures near to the melting point of the metal by direct resistance heating. Considerable quantities of these metals are now produced in the wrought form, primarily for use in the lamp and electronic industries.

The only commercially important alloys based upon the refractory metals are the molybdenum-tungsten and the tungsten-copper-nickel heavy alloys. Molybdenum and tungsten form a continuous series of solid solutions, and the 50/50 alloy, which has a better hot strength than pure molybdenum, is used in the electronics industry. The "Heavy Alloys" are tungsten-rich, containing a total percentage of copper and nickel of about 10 per cent. (A selection of components of this type was shown in the illustration at the head of the first part of this article, which appeared last week.) The powders are mixed, compacted and then sintered at about 1,450° C., when a molten alloy phase of the copper, nickel and some of the tungsten, is produced. The high density products obtained are used for mass balance weights, for the screening of radioactive materials and for electrical contacts.

Tantalum, as well as its sister metal niobium, is used in both the atomic energy and the electronic fields. In nuclear engineering, these metals may be useful as containers for the fuel. In the electronic field, tantalum is being used for capacitors and for electrodes in radio valves. Both these materials are made by sintering pressed bars by resistance heating in a vacuum. The sintered material is then processed into sheet, wire or tubing.

High strength aluminium-alumina alloys may be produced by sintering and extruding fine aluminium powder. A structure having a fine grain size which is stable at elevated temperatures can be obtained due to the dispersion of alumina in the grain boundaries. This type of structure cannot be produced by conventional melting and casting methods. Composite copper-lead bearings are another type of material which cannot be made satisfactorily by methods other than powder metallurgy.

Porous Parts. The widest applications for sintered parts so far exploited are those of ferrous and non-ferrous porous materials. The powder metallurgy process is ideally suited to the preparation of components containing a controlled amount of interconnected porosity distributed in a specified manner (Fig. 15).

Oil-impregnated, porous non-ferrous bearings are used extensively throughout the engineering industry, the most widely used being copper alloys containing from 5-12 per cent tin.

Porous iron and porous steel are being used to an increasing degree for bearing applications where higher strength is required to withstand higher bearing pressures.

Filter elements may be made from metal powders in a similar manner, and a widely used material is pre-alloyed bronze powder (90 per cent copper, 10 per cent tin). Stainless steel filters are also of importance. In both cases, it is important that the powder particles are nearly spherical and of fairly uniform size. By selection of powder and sintering conditions, filters having pore volumes of between 10 per cent and 60 per cent can be prepared.

Cemented Carbides. The carbides of the high melting point metals such as tungsten and titanium are hard and brittle and when bonded with another metal, such as cobalt, they possess outstanding properties as cutting tools. A wide field of sintered bonded carbides is now available for machine tools, dies, rock drills, etc., the composition selected being related to the particular application. The most popular variety used for machine tools has been tungsten carbide bonded with cobalt, but the factors influencing the efficiency of machining are complex, and it is only in recent years that the evaluation of various types of machine tools has been investigated. As a result, some of the more complex sintered carbides, such as those containing the mixed carbides of tungsten and titanium bonded with cobalt, have replaced the older and simpler tungsten carbide.

High Temperature Materials. The use of sintered engineering components for high temperature service under stress is a new development which is likely to become of increasing importance. High strength alloys based upon either nickel, chromium, or cobalt, and metal-bonded oxides and carbides are included in this category.

Certain alloys, when prepared by powder metallurgy methods, can show improved high temperature creep resistance over the same alloy prepared by melting and extrusion. The improved properties result from a more uniform grain size in the sintered material and probably also from the presence of a dispersed insoluble phase of oxide or nitride, resulting from surface films present on the original powder particles. High temperature fatigue resistance is comparable with that of the cast and wrought product, whilst the more uniform grain size leads to greater uniformity in thermal shock resistance.

With the promise of improved high

(*Concluded on page* 380)

Industrial Finishes Exhibition

At Earls Court, in London, this week, over 70 firms engaged in or allied to the industrial finishing industry have been exhibiting their products to the trade. The exhibits covered such sections of the trade as metal pre-treatments, paints and their applications, electroplating, galvanizing, metal colouring, anodizing, vitreous enamelling, shotblasting, vacuum deposition, and instrumentation. Below we are able to give some brief details of a few of the main exhibits at the Industrial Finishes Exhibition.

The main exhibits of **Air Industrial Developments Ltd.** were a 20 ft. long open type water wash spray booth, which naturally embodies standard features of A.I.D. spray booths, such as vitreous enamel and hinged rear screens, over and under extraction and metal eliminators housed in extended washing section. In conjunction with this spray booth was an A.I.D. electric infra red stoving oven, complete with overhead conveyor. The spray booth was fitted up for operation with 12 different types of spray guns, operating from both pressure feed paint containers and suction containers.

The A.I.D. Speeflo Hydrairless spraying equipment was also on show together with the Ionic electrostatic hand gun and both were available for demonstration.

The range of air compressors exhibited included the model 500 fully automatic two stage 50 ft^3 compressor plant, the E.P.7. 7 ft^3 portable compressor plant, the 15 V 15 ft^3 vertical fully automatic compressor plant, a 20/2B semi-automatic two stage base mounted compressor plant, having a capacity of 20 ft^3/min. and, right at the bottom of the scale, the recently introduced Aidspray atom portable spraying outfit, ideally suited for the home handyman or the small workshop.

Of particular interest were the specialist chemicals and processes of **Albright and Wilson (Mfg.) Ltd.**, particularly the new "Pyrobrite" bath for copper plating, which has outstandingly good levelling characteristics and produces close-grained, smooth deposits which do not fingermark or spot out. The firm also exhibited their range of "Plusbrite" solutions for aluminium, copper and their alloys, as well as "Plusbrite" 155 and 156 chemical brightening solutions, imparting lustrous, non-specular surfaces to aluminium and its alloys.

The firm's nickel and silver electroplating interests were also demonstrated: "Plusbrite" nickel addition agents, and silver addition agents, while nickel sulphamate and potassium stannate plating were demonstrated as well. In addition, the firm featured their design and installation service covering all types of automatic and manual plant used with their chemicals and processes.

Among the exhibits on the stand of **M. L. Alkan Ltd.** were the "Unichrome" chromium-plating barrel, which has been thoroughly proved in the U.S.A., and in which can be successfully processed many shapes and sizes of articles. Then there was the "Sel-Rex" jet plater, a complete unit for precious metal barrel and still plating, comprising tank, filter, rectifier, solution agitator, timer and control units.

Other items shown on this stand included the Micro Barrel, an horizontal unit for plating tiny components; a Coulometric thickness tester; the Hull cell control unit, by means of which plating solutions can be tested at the plating tank and remedial action taken immediately; and "Faudi" filters, units illustrating the latest improvements for the filtration of acid and alkaline solutions.

Also shown were self-regulation and crack-free chromium processes, pyrophosphate and bright cyanide copper-plating processes, cleaners, de-oxidants and metal strippers, a full range of passivating and dyeing processes, all finishes covering the previous metal plating of electronic and decorative components, and samples of dipped and spray coatings.

An interesting exhibit was provided by **F. W. Berk and Company Ltd.** (Coating Division), and included a new metal spraying pistol, the Berk model 61, which is said to be capable of spraying zinc at the rate of 110 lb/hr., with a high deposition efficiency, and aluminium and alloys at correspondingly high speeds. It is designed primarily for the spraying of large areas and, in particular, for use where heavy structural steel items and plates are to be metal sprayed after grit-blasting by automatic blasting machines.

The new "Berkalloy" powder is a zinc/aluminium alloy which has been developed after many years of research and practical tests, to give a sprayed coating with the individual characteristics of both zinc and aluminium. It, therefore, provides a universal protective coating for use against all corrosive conditions.

The full range of Berk gritblasting and metal spraying equipment was exhibited, together with examples of surface preparation and the sprayed coatings for various applications. Plastics coatings for protection and decoration by the Berk processes of flame spraying and dipping were also shown with exhibits of the equipment, including fluidizing tanks. The gritblasting machines for steel grit or non-ferrous abrasives range from heavy duty large capacity machines to the new "Slim-Jim", which is designed for working where there is limited access. The machine may be taken through an 18 in. diameter manhole. The jobbing services offered by the Coating Division were also illustrated.

A cross-section of the modern equipment and processes available to the electroplating and polishing industry was displayed by **W. Canning and Co. Ltd.** Automatic equipment was represented by the main exhibit—the loading/unloading end of a "Trojan" plant, the side elevation being shown by full scale photographs running the length of the exterior wall of the office on the stand. General equipment for the plating industry included a section of a semi-automatic barrel plating installation for bulk handling of small components.

A "Numinik" plating barrel—a submerged barrel unit fitted with a swing-over device for quick and easy loading and unloading was shown; also the "Aurax" plating barrel—a miniature barrel for gilding and plating small batches of work; the "Monarc" filter—a new 4,500 gal/hr. totally-enclosed unit for use with automatic plating equipment; the "Carboy" pump—a self-priming portable pump for safer and quick handling of plating solutions; and a whole range of polishing equipment.

On the stand of **Carrs Paints Ltd.**, a comprehensive catalogue, summarizing the range of paints, primers, varnishes and resins, etc., produced by the company, was offered. Examples of these coatings were demonstrated, and also shown were a series of coloured transparencies showing some of the well-known products which are protected by these materials.

The principal exhibits on the stand of **R. Cruickshank Ltd.** included a new "Automatic" chrome plating barrel capable of processing 6-10 lb. of components per load. The unit incorporates automatic unloading of the work when processing is completed. A new and larger version of the well-established G.P. filter, comprising twin heads and embodying all the well-known characteristics of the standard unit, was also displayed. The twin head G.P. filter is capable of a maximum output of 4,000 gal/hr. In contrast, the 301 S filter was available for inspection at the exhibition. This unit is very reasonably priced and is recommended for smaller plating installations.

In the field of standard barrel plating equipment, the exhibits included the open-ended "Senior Plater", which is rubber-lined and of sturdy construction, and also a new, fully

immersed barrel unit manufactured from P.V.C. The barrel unit is loaded and unloaded by simple hand operation.

The latest example of the "New Sheen" barrel polishing apparatus was displayed. The equipment consists of a mild steel welded hexagonal cylinder specially rubber-lined to withstand wear and avoid pecking and marking the work components. The drive is through a geared motor unit, which is fitted with a variable speed attachment, to give infinitely variable r.p.m. speed, between 10/20 or 15/30.

The recently introduced germanium rectifiers requiring considerably less installation space, and allowing certain economies of operation, were also available for inspection, and the drying equipment display was the 2.B centrifuge with a new version designed for oil separation.

Makers of specialized chemicals for industry, **Diversey (U.K.) Ltd.** were showing a complete range of products handled by their recently formed metal industries division, and among these were the following: "Aluminux"—for the production of a uniform satin etch on all aluminium alloys, giving sludge-free, scale-free etching; "No. 17"—an entirely new type of alkaline soak cleaner for aluminium. It is non-silicated and non-caustic, eliminating film and etching problems; "No. 202"—an alkaline product for the cleaning of aluminium. It has excellent detergent and emulsifying properties, and softens hard water; "No. 514"—a cold de-oxidizer in crystalline form, which produces low, uniform surface resistances. Then there is "No. 519"—a spray cleaner for ferrous and non-ferrous alloys. Its rapid wetting action enables it to penetrate soil very rapidly, and it also has water-softening properties; "No. 600"—a de-oxidizer designed especially to remove oxide from heavily heat-treated aluminium stock prior to spot-welding; and "No. 808"—a non-etching, heavy-duty alkaline cleaner, designed for the cleaning of aluminium and all ferrous and non-ferrous metals prior to anodizing, electroplating, etc. May also often be used as a substitute for vapour degreasing.

A new low-stress rhodium plating electrolyte was featured on the stand of the Baker Platinum Division of **Engelhard Industries Limited.** This new electrolyte allows for the deposition of heavy, low stress deposits, and an additional feature of the process is that the deposits are plated bright and require little final polishing. Then there was also displayed a new acid gold plating electrolyte, which is stated to be quite innocuous to most printed circuit adhesives, provides a fine gold deposit, of low stress and porosity, possessing a hardness of not less than 100 D.P.N.

Other exhibits included a palladium plating solution, the "Atomex" immersion gold solution (a recent development of this process has raised the maximum gold deposit obtainable on copper from 0·7 mg/in^2 to 3·0 mg/in^2), the "Dog-Bone" silver anodes, which conform in every respect to B.S.S.1561, and the "Silve-Brite" silver plating process, which provides a mirror-bright finish through a complete range from flash to heavy deposits.

Having recently become agents for Les Procédés Rovac of Paris, **Grauer and Weil Ltd.** naturally made a point of emphasizing the automatic Rovac "Carousel" barrel plating unit, comprising tanks set as segments of a circle within which arms fitted with barrels rotate, passing through the appropriate tanks and solutions in pre-programmed cycle. There is no overhead conveyor mechanism; the cycle time of each barrel in each solution can be adjusted from 30 sec. to many hours. Semi-automatic versions were also shown, transition from tank to tank being accomplished manually.

Portable plating barrels, in varying capacities, were displayed, as well as the established "Teddy/Dever" filters with their new close-coupled pump. Particularly interesting to smaller platers and precious metal depositers, was the new F.S.P. filter with its totally immersed pump.

Salt spray corrosion test apparatus was also shown and was of interest to "standard" conscious manufacturers, enabling them to set standards of acceptance for sub-contracted work as well as their own products.

Aircool bias buffs for all automatic polishing and buffing in all sizes and types were exhibited by **John Hawley and Company (Walsall) Ltd.** A full range of high quality stitched and loose fold buffs for manual polishing, and also Aircool bias mops for tapered spindles in Ruffel buff construction, were also shown.

In polishing compounds there was a wide selection of liquid tripolies and steel cutting compounds, and also a successful liquid white finish. There were solid compounds in a large and varied range, including "A" range of dry compounds, "H" range cut and colour compounds, and "S" range of medium greasy compounds. Also shown were all types of special-purpose compounds, from greaseless satinizing compounds to white finish.

Three important exhibits were provided on the stand of the **Hockley Chemical Company Ltd.** A section of a cam-operated automatic bright dipping or phosphating plant was shown operating mechanically. Outputs are in the region of one ton/hr. The next exhibit was the Lacromatic vibrator. This has recently been introduced to this country from Germany and is now being manufactured in Birmingham. This machine represents a great advance in deburring, descaling and surface smoothing of small components. The machine was working to show the action of vibration.

The third machine—the Lacromatic double-cone barrelling machine—was introduced to meet the requirements of modern precision finishing. Loading and unloading is said to be effortless, as hand or automatic tilting mechanism is combined. The characteristic shape of the work container gives a triple action. An automatic timing device allows operation at night without supervision. The machine is available in a range of sizes and with twin or variable speed motors, and can be used for barrelling articles up to 6 in. in length.

A wide range of products for use in industrial finishing processes was exhibited by **Johnson, Matthey and Company Limited.** For electroplating, silver anodes for use in all types of silver-plating plant were shown, together with platinum anodes for insoluble-anode processes. Salts for the electrodeposition of platinum, rhodium, palladium, gold and silver were also exhibited. The company's electroplating service for electrical and electronic components was illustrated by examples finished in rhodium, gold and silver. Another application of gold plating shown was the Acid Hard Gold process for printed circuits.

Cadmium, chromes, iron oxides and other inorganic pigments produced by the Johnson Matthey group are used in stoving and other finishes, for the colouring of all thermo and thermo-setting plastics, in rubber and in vitreous enamels. A new product featured is a metallic pigment for use in anti-corrosion finishes. Lake colours and fast pigment dyes were also on display. The company specializes in the manufacture of cadmium salts, and the exhibit included cadmium oxide, cadmium sulphide, cadmium carbonate and cadmium sulphide-carbonate.

Industrial and decorative vitreous finishes on glass and metal were shown, together with a wide selection of vitreous enamel transfers for firing to ceramics. Liquid gold preparations for decorative finishes were also included.

General Chemicals Division, Metals Division and **I.C.I. (Hyde) Ltd.** shared a stand, and a small I.C.I. drying plant for use with "Trisec" metal drying assistant was shown by General Chemicals Division. The plant, the smallest in a series of three, has an effective compartment size, 10 in. by 9 in. by 9 in. deep, and is electrically heated. The larger sizes can be gas or steam heated. The new cabinet model, ULV1 ultrasonic cleaning plant, for cleaning metal, glass and ceramic articles, was also on show. The plant, in which all pipework is concealed, has a Formica top, which is available in a range of colours. It is the smallest in a series of four standard plants and has an effective compartment size, 8 in. by 6 in. by 7 in. deep.

The use of titanium for metal finishing was featured by Metals Division, who shared a section of the stand with Imperial Aluminium Co. Ltd. Impalco were showing M32 and M32X aluminium alloys for automobile trim. I.C.I. (Hyde) Ltd. featured two products—"Novon" Ten, a hard P.V.C. foil for lamination to metal substrates, and "Vynalast", a thin, hard, semi-rigid P.V.C. foil with a paper backing which facilitates adhesion to non-metallic surfaces.

Machinery was well to the fore at the exhibit of **B. O. Morris Ltd.**, and a recently introduced machine was the Morrisflex-Hammond automatic profile polishing unit for automatically polishing profiled components such as car window vent frames, block bezels, profiled metal beadings,

shaped strip, surrounds and the like. There was also a small rotary indexing machine with 21 in. dia. table, eight work spindles, and three model 54/102 polishing heads. Other units shown included a semi-automatic polishing unit for simulating a manual operator polishing articles such as bicycle bells, etc. It enables unskilled labour to load and unload the components, and can be offered up to practically any existing user's lathe. There was a self-contained abrasive belt machine, and a complete range of tungsten carbide rotary burrs, together with a range of pneumatic diegrinders, which provide suitable driving speeds and power.

A comprehensive range of metal and plastics finishing processes was displayed by **Roto-Finish Ltd.**, and included: barrel finishing, vibratory finishing, special plant abrasive finishing, chemical cleaning, stripping, ultrasonic cleaning, degreasing and derusting, phosphating, electropolishing, and plating. In addition, the "Osromatic" vibrator finishing was demonstrated.

From **Silvercrown Limited** came an exhibit comprising illustrations of semi-automatic plating plants and "Tibmatic" barrel plating equipment, with production samples plated with the "Superbrite" and "Supersonic" bright and rapid electroplating processes.

Part of the wide range of Silvercrown auxiliary plant, such as filters, tilting barrels, centrifugal dryers, "Metabo" polishing equipment and rectifiers, were shown.

Specially featured was a small self-contained bright hard gold plating line including the special control equipment which is recommended for economical and efficient operation. Components plated with the Silvercrown bright hard gold processes were also displayed.

Shot blasting is playing an ever-increasing part in the preparation of surface finishes, and some of these applications were shown by **Tilghman's Limited** in photographs covering the surface finishing applications, surface preparation prior to painting, surface preparation prior to enamelling and surface preparation prior to metal spraying. Surface finishing applications cover such items as shot peening, roll etching, drill cleaning, die and mould cleaning, glass marking, monumental art work, polishing, and many other applications. In addition to photographs of shot-blast applications, and sample finishes on metal samples, microphotographs of finishes and grades of abrasives were exhibited.

Specially featured on the stand of **Richard Thomas and Baldwins Limited** was their "Artbrite", a P.V.C.-coated galvanized sheet. The exhibit displays a selection of the company's customers' usages of this material, demonstrating the fact that the laminated sheet is capable of withstanding forming, drawing, and fabricating processes to the extent of what the basic steel sheet will stand. Also on the stand is a display of suggested fixing and joining methods.

"Artbrite" is available in various colours and finishes.

The exhibit of the **Tin Research Institute** was devoted to the performance and applications of tin-nickel electroplate. Composed of 65 per cent tin and 35 per cent nickel, this plating has properties which are unlike those of either tin or nickel. It is ductile, very hard and reflects light strongly, especially from the red end of the spectrum.

The applications shown were grouped according to the principal functional requirement of this plating. Under the heading of anti-frictional properties, some tin-nickel plated watch parts were shown, along with some valves from a brass band instrument.

To illustrate the use of this plating against other corrosive media, plated railway signal relays, equipment used in chemical plants and electrical fitments subject to continued outdoor exposure were shown. Examples of tin-nickel applied for decorative purposes were also presented.

A new fast, air-less paint spraying unit not previously shown in this country was exhibited by **Aerostyle Limited.** This compact, self-contained mobile unit comprises a 5 gal. paint reservoir, 4 in. compressor with air gauge, 25 ft. of $\frac{1}{4}$ in. I.D. Teflon delivery hose, and spray gun with a range of tungsten carbide nozzles, the whole mounted on a "no-tilt" dolly truck approximately 24 in^2, the complete unit being about 54 in. high. This machine was demonstrated daily on the stand.

Also shown on the stand was an automatic electrostatic paint spray machine and infra-red dryer and cooler.

Powder Metallurgy — A Survey

(*Continued from page* 377)

temperature properties, sintered high temperature alloys are expected to open up a new field of application, for powder metallurgy products, particularly if advantage can be taken of producing components near to finished shape and, where necessary, incorporating cooling systems.

Bonded carbides and metal-bonded oxides have been disappointing as engineering high temperature materials, primarily because of their poor resistance to mechanical and thermal shock. More recently, however, developments in self-bonded silicon carbide and also in silicon nitride have reopened the possibility of sintered refractory non-metallic materials being used for stressed components at high temperature.

Future Trends

As the cost of good quality metal powder decreases, so the sintered product will become more competitive with cast or machined components. Cheaper methods of producing good quality powder in bulk are required, and this is particularly so in the case of powders for components.

The recent development of continuous processes such as that of rolling and extrusion of powders, and the continuous compaction of large pressings, are very important, since they offer the possibility of a useful saving in the cost of manufacture of semi-finished products, such as sheet, bar or rod. The further development of such processes will be encouraged in view of the potential challenge which they present to the conventional methods of manufacture of semi-finished materials.

The mechanical strength and ductility of sintered products, in general, need to be brought up to levels comparable to those of the materials made by conventional techniques, and although satisfactory properties can be obtained, the processes involved often make the product expensive. New and cheaper techniques for obtaining products having good mechanical properties are, therefore, required, and here there is plenty of scope for development.

With the improved laboratory techniques now available for preparing materials in a very high state of purity, the re-examination of very pure interstitial compounds such as carbides, borides, nitrides and silicides may well be worthwhile. Basic work should be aimed at understanding better the nature of bonding and the structure of such compounds, the types of defects in their structure and the contribution of these to the physical and mechanical properties of the compounds themselves. Such information should lead to a better understanding of the brittleness of such materials, and may point the way to means of overcoming it.

The effects of small quantities of insoluble refractory oxides on the properties of metals such as nickel and copper are being very actively studied. It has been shown that when the hard particle, considerably less than one micron in size, is present in a highly dispersed form, the material shows considerable resistance to both recrystallization and grain growth. The resulting stability and resistance to deformation of such materials at high temperatures result in creep and fatigue properties comparable with certain of the high temperature alloys now being used in gas turbines. The techniques of powder metallurgy offer a suitable means for obtaining the type of dispersion required, and a new family of sintered materials appears to be on the verge of commercial development.

Industrial News — *Home and Overseas*

A London Event

On Thursday, May 25 next, at the **Royal Society of Arts** building in the Adelphi, London, at 5.15 p.m., the Henry Morley Lecture will be given by Mr. Wilfred Brining, F.C.A., who has taken as his subject "Bauxite and Aluminium with Particular Reference to the Commonwealth". Mr. Brining is a director of Imperial Aluminium Company Ltd., and the lecture will be illustrated by lantern slides and a film.

Managing director of Alcan Industries Ltd., Mr. S. E. Clotworthy, C.B.E., will preside at the meeting, tickets for which may be obtained from the secretary of the Society at John Adam Street, Adelphi, London, W.C.2.

Showing in Sweden

Achievements of the **British Insulated Callender's Cables Ltd.** group in the manufacture and installation of high-voltage submarine power cables were emphasized in the display by the company at the International Swedish Industries Fair, which has been held in Gothenburg this week.

The company were represented on the Board of Trade stand. A series of pictorial units in which are featured recent and notable overseas contracts — in Canada, South America, Africa and Australia—made up the display. Samples of the cables used were incorporated.

A Removal

It has been announced by **E.M.B. Company Ltd.** that, as from Monday next, May 15, the address of their London office will be as follows—168 Park Street Lane, Park Street, St. Albans, Herts. The office will be in charge of Mr. P. N. Jay.

Trade with Bulgaria

According to Board of Trade information, in the twelve months ending March 31, 1962, Bulgaria intends to buy metals worth £600,000 through United Kingdom merchants. No breakdown of the total has been announced.

High Frequency Generators

In accordance with their policy of constant development aimed at improving their products, **Wild-Barfield Electric Furnaces Ltd.** have improved their range of high frequency generators that originally covered outputs from 15 to 40 kW. The new sets have continuous outputs to B.S.1799 of 18 kW, 27 kW, 36 kW, and 45 kW, and it is understood that the increase has been achieved without any additional floor space being needed.

The company states that reliability is now even greater, maintenance has been simplified, and sets between 18 and 36 kW have been designed so that they may be readily converted to a higher output, up to 45 kW, in fact, the conversion being carried out in the user's premises in a few hours.

New Aircraft Wheel

A rustproof aircraft wheel that will withstand more than 1,000° F. was unveiled recently at the American Western Metal Exposition. Titanium is the principal element in the new wheel, built by Goodyear in the United States to meet the severe operating requirements of high speed jet aircraft.

The new wheel is said to have passed successfully all necessary tests, and can be produced commercially. This wheel is stated to be lighter in weight and able to withstand greater impact loads without failure, due to increased flexibility.

American Zinc

Consumption of zinc die-castings by the motor car industry should rise by some 17 per cent in the 1960s if present consumption patterns continue. This increase in zinc consumption—including all makes and models—will reflect emerging trends in car ownership that promises seven million new car sales by 1965 and eight million by 1970.

These predictions were made and substantiated by Mr. E. C. Quinn, Vice-President, sales divisions, of the Chrysler Corporation, in a talk on new patterns in world motor car competition, delivered last week before the American Zinc Institute's 43rd annual meeting in Chicago.

In a talk entitled "Lead and Zinc in a Changing World", Mr. R. Lewis Stubbs, director-general, Zinc Development Association (London), reported that consumption of zinc has been rising steadily in Europe, increasing from an annual 700,000 metric tons ten years ago to 1,100,000 metric tons today. Mr. Stubbs said consumption of zinc in nations outside Europe and North America is also advancing, especially in Japan, Australia and India, and today accounted for some 15 per cent of world zinc consumption—twice the tonnage of ten years ago.

Annual Luncheon

It has been announced by the **National Association of Non-Ferrous Scrap Metal Merchants** that the annual luncheon will be held this year on Wednesday, June 14, at Grosvenor House, Park Lane, London, W.1, at 12.45 p.m.

New Factory

Recent news from **Desoutter Brothers (Holdings) Ltd.** is that they have acquired a factory of 25,000 ft² at Angmering, Sussex, formerly occupied by Crawley Metal Productions Ltd. This factory is fully equipped with machinery for the business of contract repetition engineers, and will give a valuable increase in manufacturing facilities to the company.

It is intended that a new wholly-owned subsidiary will be formed to operate this new acquisition as a separate unit of the Desoutter group.

Aluminium Lawn Edges

A new and inexpensive means of keeping garden lawn edges straight and tidy without constant cutting back has recently been introduced by **The British Aluminium Company Limited.** It consists of a roll of aluminium strip, 4 in. wide and 33 or 100 ft. long, which goes into the ground round the lawn and, being flexible, fits any shape of border.

The top of the strip, which is lightly corrugated for strength, is placed just below the level of the lawn, so that the mower blades can pass over it. This is deep enough to prevent the grass roots spreading on to the path or the beds.

The edges of strip have been turned down, so there is no risk of cuts while fixing it. This consists simply of scraping away the earth from the edge of the lawn, putting the edging alongside just below the level of the grass, and replacing the soil. No supports or pegs are needed, and no hammering is required. Being made of aluminium it cannot rust and has an indefinite life.

A Measurement Chart

A wall chart has been introduced which demonstrates how an irregular area is measured by a Gunter's Chain and by an Invar Band. A diagram also shows how the information is transferred from the field book to the drawing board. Further drawings illustrate the uses of steel survey bands, woven and steel measuring tapes, and push-pull rules.

The chart is 20 in. by 30 in., is priced at 1s. and is produced by **Educational Productions Limited,** in collaboration with James Chesterman and Company Ltd.

Factory Extensions

Under this heading on page 342 of our issue of April 28 last, reference was made to the extensions to the works of Faulkners Limited at Colnbrook, Bucks. We omitted to mention, however, that the work of extension was carried out by **E. W. Tyler and Company Ltd.,** precast engineers, of Tonbridge and Manchester.

New Sales Office

News from **Spartan Steel and Alloys Ltd.** is that they have opened a sales office at 534 Attercliffe Road, Sheffield, with the telephone number of 49551-2, Sheffield.

Bronze and Brass Founders

At the annual and general meetings of the **Association of Bronze and Brass Founders,** held on Thursday of last week, **Mr. W. R. Buxton** was elected President; **Mr. E. Ayres,** Vice-President, and **Mr. A. J. N. Brown,** Immediate Past-President, all three being automatically members of the Council.

Members of the Council were elected as follows: **Mr. W. A. Bannister, Mr. W. R. Blakeborough,** J.P., **Mr. E. J. Brooke, Mr. F. G. Burgess, Mr. F. G. Burrell,** O.B.E., **Mr. G. H. Charsley, Mr. P. B. Higgins, Mr. W. T. Hobkirk,** J.P., **Lt.-Col. R. C. Hoult,** M.B.E., **Mr. G. T. Hyslop, Mr. J. M. Langham, Mr. W. S. Lawson, Mr. C. E. Lovelace, Mr. W. R. Marsland, Mr. J. J. Mundell, Mr. J. C. Sheckell,** and **Mr. A. P. Wright.** As chairman of the Technical Committee, **Mr. G. Swinyard** is *ex officio* a member of the Council.

Members of the Technical Committee were appointed as follows: **Mr. G. T. Callis, Mr. P. B. Cross, Mr. R. W. Eade, Sir Thomas Ferens,** O.B.E., **Mr. G. L. Harbach, Mr. B. R. Higgins, Mr. E. F. Hodges, Mr. R Lancaster, Mr. C. McNair, Mr. N. D. G. Robertson, Mr. H. T. Rutter, Mr. A. L. Wakeling, Mr. E. Wallace, Mr. A. Wilkinson, Mr. A. P. Wright,** and **Mr. A. W. O. Webb,** with **Mr. F. C. Evans, Mr. E. C. Mantle** and **Mr. F. Hudson** as co-opted members.

In his report on the past year, the retiring President, **Mr. A. J. N. Brown,** referred to the activities of the Council and the Association, including safety, health and welfare meetings, prices of metals, the key industry duty on electrolytic manganese, the European committee of foundry associations, recruitment and training, foundry industries liaison, wages and costs, and the future of the industry and of the Association.

Concluding his report, Mr. Brown thanked all the members of the Council for their help and guidance during the year, also the Technical Committee for their invaluable work, and especially to **Mr. Rogers** and **Mr. Sims,** the secretaries, for their wholehearted work and help.

The report of the Technical Committee was then presented, and among the items referred to was the B.S.1400 revision, other British standards, international standards, promotion of the use of copper alloy castings, inspection procedure, and the technical advisory and research liaison committee.

At the conclusion of the meetings, **Mr. R. Lancaster,** after nine years as chairman of the Technical Committee, resigned from that position owing to pressure of work in his own business, and was succeeded as chairman by **Mr. G. Swinyard,** of the Phosphor Bronze Company Ltd. The retiring President of the Association made a presentation to Mr. Lancaster on behalf of the members, of a projector and screen, and referred in appreciative terms to the work which Mr. Lancaster had done during the years he had been chairman of the committee.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell by 311 tons to 9,616 tons, comprising London 4,254, Liverpool 3,609 and Hull 1,753 tons.

Copper stocks rose by 600 tons to 15,657, distributed as follows: London 800, Liverpool 12,732, Birmingham 100, Manchester 1,975, and Hull 50 tons.

Lead duty-free stocks rose by 50 tons to 8,096 tons, comprising London 7,981, Glasgow 15, and Swansea 10 tons, while in-bond stocks remained unchanged at 3,868 tons, all supplies in London.

Zinc duty-free stocks rose by 737 tons to 4,733 tons, and comprised London 3,500, Liverpool 1,118, and Glasgow 115 tons, while in-bond stocks rose by 375 tons to 1,491 tons, all supplies in London.

Aluminium in India

According to news from Milan, the Italian company Montecatini has announced that it has concluded an agreement with the Madras Aluminium Company Limited to build a plant in the state of Madras, India, for the production of 10,000 tons annually of aluminium ingots and aluminium alloys.

Montecatini will provide technical assistance in the building of the plant, and will help to run it. The Madras Aluminium Company was formed by Montecatini, the Indian Government and private groups.

Southern Rhodesian Output

Production of copper in Southern Rhodesia amounted to 951 tons during March this year, compared with 614 tons in February and 1,014 tons in March 1960, figures issued by the Department of Mines in Salisbury reveal. During the first three months of the current year, production totalled 2,105 tons, against 3,107 tons in the corresponding period in 1960.

Production of tin metal during March this year in Southern Rhodesia amounted to 58·49 tons, compared with 52·84 tons in February and 66·76 tons in March 1960. During the first three months of the current year, production totalled 169·54 tons, compared with 173·56 tons in the corresponding period a year ago.

Production of tin concentrates totalled 8·6 tons in March, against 4·56 tons in February and 4·20 tons in March 1960, while the total for the first three months of the current year was 17·20 tons, and 13·64 tons a year ago.

Lead Production This Year

Production of refined lead in 1961 will be about 70,000 tons below that of 1960, according to the estimates given by Mr. R. Lewis Stubbs, O.B.E., at Chicago recently. Mr. Stubbs, the Director-General of the Lead Development Association and the Zinc Development Association, thought that the cuts in production agreed upon at the recent meeting of the International Lead and Zinc Study Group in Mexico City would do much to correct the imbalance in lead supply and demand in the Free World. Furthermore, producers' stocks outside the U.S.A. would be reduced by 75,000 to 100,000 tons when the present negotiations for the barter of U.S. agricultural products for producers' surplus lead stocks were completed.

Mr. Stubbs, who was addressing a joint session of the American Zinc Institute and the Lead Industries Association, was confident that lead prices would be more stable this year and at a level which would satisfy both producers and consumers. Zinc supplies had recently exceeded demand but the market was buoyant, because consumption in Europe was rising and the prospects in the U.S.A. were good.

Reviewing recent trends in the consumption of lead and zinc, Mr. Stubbs referred to the striking difference between Europe and the U.S.A. In Europe, where consumption was rising, the additional uses of both metals still accounted for the bulk of their use and showed no signs of declining. The newer uses were developing but had far to go before they reached the importance they had in the U.S.A. In zinc, both strip galvanizing and die-casting would continue to expand, and lead would benefit from the increase in motor cars, which would use more batteries and tetraethyl lead in petrol.

The newly developing countries, too, were using more zinc and lead, and their economies would continue to grow. The recent levelling off in the consumption of lead and zinc was partly due to the success of the aggressive advertising campaigns for the newer materials. Proposals for increasing the promotional work for lead and zinc were made by Mr. Stubbs, who referred especially to the need to develop their uses in the newly expanding countries in Asia, Africa and South America.

Symposium for 1962

Sponsored by the Institute of Physics and the Physical Society, in collaboration with the British Nuclear Energy Conference, a Symposium on "The Physics of Graphite-moderated Reactors" is to be held in Bournemouth on April 4-6, 1962. The provisional programme includes a half-day's visit to the Atomic Energy Establishment at Winfrith, Dorset. A number of Papers have already been promised and further contributions will be considered by the committee. The Symposium is intended particularly for the less senior members of the research and development staffs working in this field. First preference to attend will be given to members of the constituent bodies of the British Nuclear Energy Conference, one of which is the sponsoring organization. Communications about the Symposium should be addressed to the Secretary of the Institute and Society at 47 Belgrave Square, London, S.W.1.

Electronic Conveyor Control

It has been announced that the Electronics Division of **Bruce Peebles and Co. Limited** has received an order from the Head Wrightson Machine Co. Limited for an electronic control system for the overhead magnetic conveyors on the steel strip cut-up lines at the Spencer Works of Richard Thomas and Baldwin Ltd.

This largely static control system will employ silicon-controlled rectifiers and solid-state circuits, and will control, automatically and in the correct sequence, the excitation supplies to sections of electromagnets in the overhead conveyor lines. Each of these lines will form part of the classifier section of a side-trim and cut-up line handling steel strip 0·02-0·1 in. thick in widths of up to 5 ft. and at speeds of up to 960 ft/min. The classification will be entirely automatic, each sheet being released from the conveyor on to either a "prime" or a "reject" pile by the high-speed switching of the appropriate magnet excitation in response to the output of a classifier unit. This unit (the supply of which is out with the present contract) interprets signals from separate sheet inspection equipment.

The control equipment is scheduled for delivery late this year.

Sole Licensees

We are informed by **B. O. Morris Ltd.** that they have been appointed sole licensees in the U.K. and E.F.T.A. countries, for the manufacture, importation and marketing of the Scully-Jones range of quick change preset precision tool holders.

This comprehensive range, which is particularly suited to transfer and automation machines, is also widely used for economic and accuracy reasons on standard machine tools.

All S.-J. tool can be incorporated into the "Toolitrol" system, which controls all the tool changing cycles on any machine, stores preset tools ready for quick changing, and cuts "down time" to the minimum whilst guaranteeing a consistently high standard of machining accuracy.

New Range of Electrodes

Elimination of objectionable welding fumes, together with improved slag detachability are the main features of the new Diadem "Ruby" range of electrodes recently introduced by **Cooper and Turner Ltd.**

This mild steel electrode is designed primarily for fast, high quality welds in the downhand position, although it is also suitable for vertical and overhead work. The Ruby range has full M.O.T., Lloyd's and other official approvals. It complies with B.S.639:1952, and B.S.1856, regarding mild steel welding requirements, and such other British Standards as B.S.2642, covering the metal arc welding of medium tensile weldable structural steel, to B.S.968. Due to careful matching of the core wire

and covering, it is particularly suited to the production of smooth, dense welds of high strength, ductility and toughness by welders of only limited experience.

A Joint Summer Meeting

On Friday and Saturday, May 26 and 27, a joint summer meeting is to be held in Hereford of the Midlands and Western sections of the **Society for Analytical Chemistry.** The proceedings will open on the Friday, at 2.15 p.m., with a visit to the cider factory of H. P. Bulmer and Company Ltd., to be followed at 7 p.m. by a meeting in the Town Hall, at which Mr. J. R. Millar, M.A., F.R.I.C., will give a lecture on "The Application of Ion Exchange Resins to Metallurgical Analysis".

The morning of Saturday will be taken up by a coach tour of the Vale of Evesham, and in the evening an informal dinner at the Green Dragon Hotel, Hereford.

Registration of Copper Brand

Registration of the "L.M.C." brand of electrolytic copper cathodes under Class B (1) of the Standard Copper Contract, has been approved by the Committee of the London Metal Exchange, and such brand will constitute a good delivery against all contracts maturing after May 4 last. The producers of this brand are Lewin-Matthes Company Division, Cerro Corporation, St. Louis, Missouri; Refinery: Monsanto, Illinois, U.S.A.

Scientific Instruments on Show

A comprehensive cross-section of laboratory instruments and furniture for every type of scientific research, development and industrial laboratory, manufactured or stocked by the **Griffin and George** group of companies, will be shown at the Laboratory Apparatus and Materials Exhibition, which is to be held in London next month.

Among the many instruments to be shown for the first time at this exhibition will be the Griffin "D-6" chromatograph, which is stated to be the first ever to use, as detector, the Martin gas density balance. Shore scleroscopes for the testing of hardness of metals will be on show, as also will the Griffin oscillating hotplate, a combination of hotplate and oscillating unit which enables the heating and agitation of liquids to be effected simultaneously.

National Physical Laboratory

In the leading article on page 369 this week some of the activities of the National Physical Laboratory, as described in the Laboratory's Report for 1960, are referred to. Copies of this report may be obtained from H.M. Stationery Office, price 9s. 6d., by post 10s. 2d.

New British Company

An announcement has been made by **Wickman Limited** and L. Schuler A.G., of Goeppingen, Germany, to the effect that they propose to form a jointly-owned British company with the title of Schuler Presses Limited.

The new company has been formed to establish the manufacture of certain Schuler presses in the U.K. and to provide a U.K.-based engineering and after-sales service to all Schuler press users. The range of presses concerned include open-fronted, upright and inclinable presses, double-sided eccentric, crank and drawing presses, high-speed blanking and four-pillar dieing presses, high-speed notching presses and vertical cold flow presses.

Men and Metals

As from May 1 last, the office of President of the Royal Institution of Naval Architects has been assumed by **Viscount Simon**, C.M.G., in succession to **Viscount Runciman of Doxford,** O.B.E., A.F.C., D.C.L., who held the office from 1951.

Formerly general manager of Thor Tools Limited, **Mr. H. W. Winham** has been appointed director and general manager of the John Vickers group of companies of founders, engineers and patternmakers.

New Castrol group appointments have been announced as follows: **Mr. R. T. Miller** has been appointed managing director, and **Mr. A. George,** assistant managing director, of Fletcher Miller Limited.

A director of Aluminium Limited, **Mr. M. P. Weigel,** of Montreal, has been appointed a vice-president of the company, and **Mr. D. A. Petapiece** has been appointed an assistant secretary.

Manager of the Baronet Works, Warrington, of Laporte Chemicals, **Mr. G. F. Sommerville** has been appointed a director of that company.

Works manager of the Sheffield Wire Rope Company Limited, **Mr. F. R. Swinden** has been appointed an executive director of the company, which is a member of the Firth Cleveland group.

It is announced that **Mr. A. J. Webster** has been appointed assistant managing director of Midland Aluminium and the London Aluminium Company.

Returning to South Africa, where he will continue to be in charge of Tube Investments Limited's interests in the Union, **Sir Francis W. de Guingand** has resigned his directorships of British Aluminium Company Limited and its subsidiary, Canadian British Aluminium Company.

It is reported that three new directors have been appointed to the board of Brookhirst Igranic as follows: **Mr. N. Clark,** secretary; **Mr. H. Rothwell,** chief developments engineer; and **Mr. A. E. Williams,** chief application engineer.

Two announcements have recently been made by Associated Electrical Industries Limited. One concerns the retirement of **Mr. D. W. Evans,** assistant sales manager, traction department (Rugby), who retired at the end of last month. He had been with the company forty years. The other relates to the appointment of **Mr. G. F. Gribbin,** B.Sc., A.M.I.E.E., who is appointed sales manager of the X-ray department. He has been assistant sales manager since August 1957.

After a long association, **Mr. C. D. B. Williams** has relinquished his appointment as technical consultant and United Kingdom agent for the Dutch and American Van de Horst companies.

Appointed technical manager of Burtonwood Engineering Company, **Mr. Brian Pavey,** B.Sc., I.R.E., has been gaining experience with U.S. Industries Inc., the American corporation which controls Burtonwood. Mr. Pavey took up his new appointment last month.

After 41 years with the A.E.I. group of companies, **Mr. Norman Elce,** M.Sc., M.I.Mech.E., F.R.S.A., director and chief mechanical engineer, Associated Electrical Industries (Manchester) Ltd., has retired. He has been appointed consultant to the managing director at Manchester.

In succession to **Mr. A. J. N. Brown,** of Stevens and Struthers Limited, **Mr. W. R. Buxton,** of the Eyre Smelting Company Limited, has been elected President of the Association of Bronze and Brass Founders.

It has been announced by Crofts (Engineers) Limited that they have appointed **Mr. John R. Mitchell** as their technical representative for the Sheffield area. He will be located at 12 Collegiate Crescent, Sheffield, 10. Mr. Mitchell was educated at Calder High School and Percival Whitley College, and holds the Higher National Certificate in mechanical engineering.

As from June 1 next, **Mr. R. A. K. Loxley** has been appointed market and research officer by the Council of Ironfoundry Associations, in co-operation with the National Federation of Engineering and General Ironfounders.

A member of the B.S.A. group of companies, Jessop - Saville Limited announce the appointment of **Mr. G. T. Harris,** M.A., F.Inst.P., F.I.M., as assistant managing director. He has been with the organization for more than 20 years. Another appointment to the board is that of **Mr. J. G. Ryder,** who recently joined the company to take complete charge of production.

Appointed industrial safety officer for the Bradley and Foster group of seven companies in Staveley Industries Limited, **Mr. Thomas Murray** will be based at the head office of the group at Darlaston.

Previously chief designer with R. Cruickshank Limited, and plant consultant to Magnus Chemical Company Limited, **Mr. F. W. Batty** has joined the staff of PMD Chemical Limited.

Chairman of the Rhodesian Selection Trust Group, **Sir Ronald L. Prain** has been appointed chairman of the Commonwealth Council of Mining and Metallurgical Institutions.

Metal Market News

ENCOURAGING figures in respect of March have been issued by the British Bureau of Non-Ferrous Metals Statistics, and there seems to be good ground for optimism about the future. Consumption of copper, all grades, in the United Kingdom, was 64,765 tons, compared with 55,946 tons in February, but the total for the first quarter of this year, at 179,866 tons, registered a decline of 7,019 tons on the figure for the corresponding period last year. Stocks of copper, all grades apart from scrap, at the end of March amounted to 118,722 tons, compared with 115,306 tons at February 28. There was also an increase in the usage of tin, which rose from 1,760 tons in February to 2,092 tons in March. Stocks of tin in the U.K. at March 31 were 12,398 tons, an advance of 322 tons on the February figure.

Last week proved to be a period of great trading activity in the standard copper market, where the total turnover, including carries and transactions put through on the Kerb, amounted to not much less than 20,000 tons. This is easily the largest volume of trading in one week seen in Whittington Avenue for a long time past and may, perhaps, be regarded as a happy augury for the renovated Metal Exchange. Apart from a short-lived setback on the afternoon Kerb market last Thursday afternoon, the quotation advanced steadily throughout the week to finish up £6 5s. 0d. better for cash at £241, and £5 15s. 0d. up for three months at £241 15s. 0d. The contango, it will be noted, narrowed from 25s. to 15s. The principal reason for the strength of the copper market in London last week was the advance in the United States quotation by 1 cent to 30 cents on May 1. But more than that, the very firm tone of the scrap market and the sharply rising Comex quotation both pointed to the likelihood of a further advance in the American domestic price, at any rate for the custom smelters. In fact, it is difficult to see how a further appreciation can be avoided, for scrap is exceedingly scarce in the United States, due to heavy and continuous purchasing by Japan. This has forced up the price of secondary metal which, in turn, has operated to raise the custom smelters price for refined copper on the domestic market. Stocks of copper in L.M.E. official warehouses rose by 115 tons to 15,057 tons.

It would appear that a fairly active demand from the Continent was in evidence, but there is some doubt about the response in the U.K., where consumers undoubtedly feel that the rise has gone rather too fast and too far. However, it does not appear that they can do much about it, for the American situation has developed great strength, and as we write, there is every appearance of a further appreciation. Just how far this will extend, it is hard to say, but a price of £245 is by no means out of the question. L.M.E. warehouse stocks of tin dropped by 190 tons to 9,927 tons, and the market showed great strength, the cash price advancing by £15 to £858, and three months by £11 to £860. The turnover, with Kerb trading, was about 1,000 tons. Values are talked much higher in the near future. Trading in lead was rather slow and ineffective, with a turnover of 6,000 tons. At £67 17s. 6d., cash was 7s. 6d. down on the week, while three months was unchanged at £69 5s. 0d. Some 6,000 tons of zinc changed hands with a 10s. loss in both positions to £83 10s. 0d. L.M.E. stocks were 267 tons up at 5,112 tons.

Birmingham

Business continues active in the metal-using industries in Birmingham and the Black Country. With the slow but sure recovery in the motor trade, there is an expanding demand for a wide variety of metal components, and the outlook for these firms is satisfactory. In the brassfoundries and aluminium castings shops there is a steady flow of business. Toolmakers are busy. Light engineering activity continues one of the most active sections of industry throughout the area. Makers of electrical equipment for power stations continue well-situated for orders. The boom in the building industry is maintained.

Steel producers have planned extensions to existing works to meet with increasing demand. Output of most products is expanding. The call for joists, sections, angles and reinforcing bars is particularly heavy. With a wider range of steel products being rolled, customers are able to get delivery reasonably quickly. Imports of semi-finished steel are much lower as compared with a year ago, and apart from some special grades, the needs of re-rollers are being met without difficulty by British steelworks. There is a bigger demand for castings and pressings for the motor trade. Supplies of pig iron are adequate.

New York

At the week-end, copper futures were firm on new speculative buying in active dealings. Traders noted the continued bullish feeling in copper. Custom smelters were not anxious to sell at 30 cents per lb. The indicated demand was greater than their available supplies. Producers also indicated continued good interest. Some sources believe that another custom smelter price increase of 1 cent is building up. Scrap copper was firmer, up another ¼ cent per lb. Tin was strong but inactive, buyers backing away from the sharp advance. Zinc was fairly active and lead was quiet.

A Kennedy Administration decision on measures to aid the U.S. lead/zinc industry is to be sent to Congress later this month, a top Interior Department official said. Mr. Joseph McCaskill, head of the department's Lead/Zinc Office, told the Subcommittee on Minerals that several specific proposals had been submitted to the Budget Bureau and that a final Administration position on lead/zinc legislation should be ready by May 15. Pending the final decision, Mr. McCaskill said it was inappropriate for him to disclose details of the Department's proposals.

It is speculated that the proposals may include a subsidy programme for producers of under 500 tons, some type of depressed area aid and, perhaps, even a plan in which the Government would buy up and place in Federal stockpiles surplus lead stocks of about 10,000 tons. Most of the Interior Department official's testimony before the Subcommittee was spent defending the recently-announced Government plan to barter surplus agricultural commodities for world surplus lead stocks. He said that the barter deals and voluntary cutback agreements to reduce total 1961 world lead mine output by 70,000 tons and smelter production by 85,000 tons, should firm up world markets and force a moderate increase in prices. Mr. McCaskill told the Subcommittee that one of the great unknowns was what Russia would do. He added that attempts were made at the recent Study Group meeting to pin down Soviet intentions, but they met with little success.

Zurich

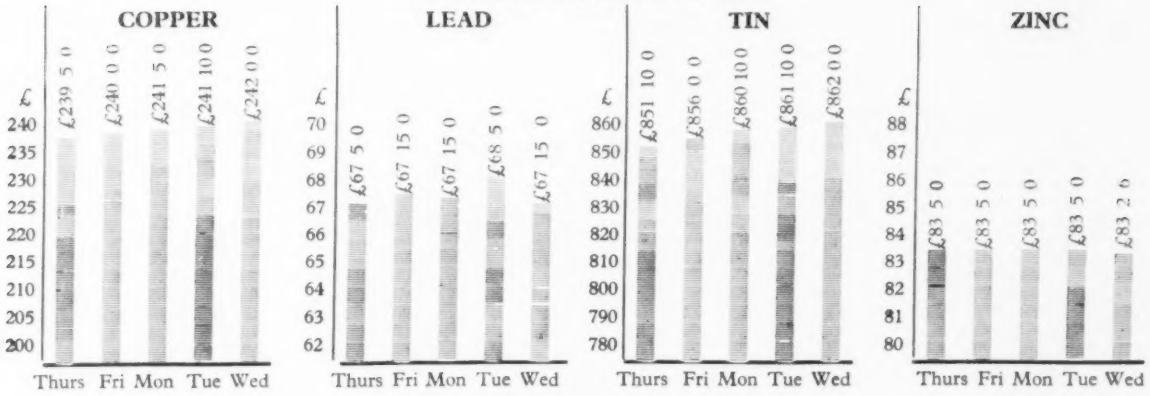
The main features of the Swiss non-ferrous metals market last month were approximately stable sales of zinc, lead and nickel and increased demand for copper, tin and aluminium. According to trade quarters, business on the copper market was extremely lively, largely due to rising demand for copper sheet by the building industry, which, at present, is experiencing an unprecedented boom. In addition, there was buying on a considerable scale by machinery and engineering firms, particularly for brass products for export.

The increased demand for tin was mainly due to decline in offerings of readily available metal. On the aluminium sector, sales increased, while trading in zinc and lead was quiet. Swiss metal prices advanced in April, mainly in the copper and tin sector, while crude zinc and nickel prices remained stable and high-grade zinc prices eased slightly.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 4 May to Wednesday 10 May 1961



Primary Metals

All prices quoted are those available at 2 p.m. 10/5/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	,,	237	10	0
Antimony Metal 99%	,,	230	0	0
Antimony Oxide Commercial	,,	194	10	0
Antimony White Oxide	,,	212	0	0
Arsenic	,,	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	,,		11	0
Calcium	,,	2	0	0
Cerium 99%	,,	15	0	0
Chromium	,,		6	11
Cobalt	,,		12	0
Columbite	per unit		8	10	0
Copper H.C. Electro	ton	242	0	0
Fire Refined 99·70%	,,	241	0	0
Fire Refined 99·50%	,,	240	0	0

		£	s.	d.
Copper Sulphate	ton	78	0	0
Germanium	grm.		—	
Gold	oz.	12	10	9½
Indium	,,		10	0
Iridium	,,	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	67	15	0
Magnesium Ingots	lb.			
99·8%	,,		2	2½
99·9+%	,,		2	3
Notched Bar	,,		2	9½
Powder Grade 4	,,		5	6
Alloy Ingot, AZ91X		1	11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	67	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	,,		5	6
Osmium	oz.	20	0	0
Osmiridium	,,		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	,,	30	5	0
Rhodium	,,	46	0	0
Ruthenium	,,	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	7⅛
Tellurium Sticks	lb.	2	0	0
Tin	ton	862	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	,,		—	
Virgin Min 98%	,,	83	1	10½
Dust 95/97%	,,	125	0	0
Dust 98/99%	,,	131	0	0
Granulated 99+%	,,	108	1	10½
Granulated 99·99+%	,,	122	0	0

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg≏£/ton	**Canada** c/lb≏£/ton	**France** fr/kg≏£/ton	**Italy** lire/kg≏£/ton	**Switzerland** fr/kg≏£/ton	**United States** c/lb≏£/ton
Aluminium		26.00 210 12	2.43 179 11	370 216 1	2.50 210 5	26.00 207 4
Antimony 99.0			2.80 206 18	520 303 13		32.50 259 0
Cadmium			16.25 1 200 17			160.00 1,275 4
Copper						
Crude				450 262 16		
Wire bars 99.9						
Electrolytic	33.00 241 3	28.25 228 16	3.32 245 6		2.85 239 13	30.00 239 2
Lead		10.00 81 0	.96 70 18	166 98 0	.80 67 5	11.00 87 13
Magnesium						
Nickel		70.00 567 0	9.00 665 2	1,180 689 2	7.50 630 15	74.00 589 15
Tin	119.75 875 5		12.13 896 8	1,590 928 11	10.30 866 4	109.50 872 14
Zinc						
Prime western		12.25 100 4 0				
High grade 99.95		12.85 104 17 0				
High grade 99.99		13.25 107 6 0			1.05 88 6	
Thermic			1.23 90 17			
Electrolytic			1.31 96 16	189 110 7		13.00 104 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 10 5 61

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10 .... „	221	0	0
B.S. 1490 L.M.11 .... „	215	0	0
B.S. 1490 L.M.12 .... „	223	0	0
B.S. 1490 L.M.13 .... „	216	0	0
B.S. 1490 L.M.14 .... „	224	0	0
B.S. 1490 L.M.15 .... „	210	0	0
B.S. 1490 L.M.16 .... „	206	0	0
B.S. 1490 L.M.18 .... „	203	0	0
B.S. 1490 L.M.22 .... „	210	0	0
Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton	171	0	0
B.S. 1490 L.M.2 .... „	174	0	0
B.S. 1490 L.M.4 .... „	180	0	0
B.S. 1490 L.M.6 .... „	181	0	0
***Aluminium Bronze**			
BSS 1400 AB.1 ..... ton	254	0	0
BSS 1400 AB.2 ..... „	262	0	0

*Brass	£	s.	d.
BSS 1400-B3 65/35 .. ton	185	0	0
BSS 249 ..... „		—	
BSS 1400-B6 85/15 .. „	231	0	0
***Gunmetal**			
R.C.H. 3/4% ton .... „		—	
(85/5/5/5) LG2 ..... „	230	0	0
(86/7/5/2) LG3 ..... „	240	0	0
(88/10/2/1) ..... „	303	0	0
(88/10/2/½) ..... „	293	0	0
***Manganese Bronze**			
BSS 1400 HTB1 ..... „	201	0	0
BSS 1400 HTB2 ..... „	219	0	0
BSS 1400 HTB3 ..... „	237	0	0
Nickel Silver			
Casting Quality 12% „	258	0	0
„ „ 16% „	270	0	0
„ „ 18% „	310	0	0
***Phosphor Bronze**			
B.S.1400P.B.1.(A.I.D. released) ..... „	320	0	0
B.S. 1400 L.P.B.1 „	252	0	0

**Average prices for the last week-end.*

Phosphor Copper	£	s.	d.
10% ..... ton	260	0	0
15% ..... „	263	0	0
Phosphor Tin			
5% ..... „	922	0	0
Silicon Bronze			
BSS 1400-SB1 ..... „	295	0	0
Solder, soft, BSS 219			
Grade C Tinmans ... „	394½	0	0
Grade D Plumbers .. „	314	10	0
Grade M ..... „	433	10	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „ „		—	
Zinc Alloys			
BSS 1004 Alloy A .. ton	116	10	0
BSS 1004 Alloy B.... „	120	10	0
Sodium-Zinc ..... lb.		2	7

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium					
Sheet	10	S.W.G.	lb.	2	10½
Sheet	18	S.W.G.	„	3	0½
Sheet	24	S.W.G.	„	3	3½
Strip	10	S.W.G.	„	2	10½
Strip	18	S.W.G.	„	2	11½
Strip	24	S.W.G.	„	3	1
Circles	22	S.W.G.	„	3	4½
Circles	18	S.W.G.	„	3	3½
Circles	12	S.W.G.	„	3	2½
Plate as rolled			„	2	10
Sections			„	3	4
Wire 10 S.W.G.			„	3	1½
Tubes 1 in o.d. 16 S.W.G.			„	4	4
Aluminium Alloys					
BS1470. HS19W.					
Sheet	10	S.W.G.	„	3	3
Sheet	18	S.W.G.	„	3	5½
Sheet	24	S.W.G.	„	4	1
Strip	10	S.W.G.	„	3	3
Strip	18	S.W.G.	„	3	4½
Strip	24	S.W.G.	„	4	0½
BS1477. HP30M.					
Plate as rolled			„	3	1
BS1470. HC15WP.					
Sheet	10	S.W.G.	„	4	3
Sheet	18	S.W.G.	„	4	8½
Sheet	24	S.W.G.	„	5	8½
Strip	10	S.W.G.	„	4	4
Strip	18	S.W.G.	„	4	8½
Strip	24	S.W.G.	„	5	4½
BS1477. HPC15WP.					
Plate heat treated ...			„	3	10½
BS1475. HG19W.					
Wire	10	S.W.G.	„	4	2
BS1471. HT19WP.					
Tubes 1 in. o.d. 16 S.W.G.			„	5	5
BS1476. HE19WP.					
Sections			„	3	4
Split tube					
19 S.W.G. (⅜")			„	4	2
20 S.W.G. (⅜")			„	3	11
21 S.W.G. (⅜")			„	4	1
22 S.W.G. (¼")			„	4	11
Welded tube 14 to 20 S.W.G. (sizes ½" to 1½")			„	3/10½ to 5/8½	

Brass					
Tubes			lb.	1	10½
Brazed Tubes			„	3	3½
Drawn Strip Sections			„	3	3
Sheet			ton	210	0 0
Strip			„	210	0 0
Extruded Bar			lb.	2	1½
Condenser Plate (Yellow Metal)			ton	195	0 0
Condenser Plate (Naval Brass)			„	208	0 0
Wire			lb.	2	9½
Beryllium Copper					
Strip			„	1	4 11
Rod			„	1	1 6
Wire			„	1	4 9
Copper					
Tubes			lb.	2	4
Sheet			ton	278	15 0
Strip			„	278	15 0
H.C. Wire			„	292	5 0
Cupro Nickel					
Tubes 70/30			lb.	3	7½

Lead			
Pipes (London)	ton	107	0 0
Sheet (London)	„	104	15 0
Tellurium Lead	„	£6 extra	
Nickel Silver			
Sheet and Strip 10% ..	lb.	3	11
Wire 10%	„	4	4
Phosphor Bronze			
Wire	„	4	3½
Titanium (1,000 lb. lots)			
Billet 4½" to 18" dia.....	lb.	47/-	48/-
Rod ½" to 4" dia.....	„	85/-	53/-
Wire ·036"-232" dia....	„	159/-	99/-
Strip ·001" to ·048"....	„	350/-	68/-
Sheet 8'×2'. 20 gauge	„	73/-	
Tube, representative average gauge	„	198/-	
Extrusions	„	90/-	
Zinc			
Sheet	ton	121	10 0
Strip	„	nom.	

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 9/5/61.

Aluminium	£
New Cuttings	140
Old Rolled	105
Segregated Turnings	74
Brass	
Cuttings	168
Rod Ends	152
Heavy Yellow	143
Light	138
Rolled	157
Collected Scrap	142
Turnings	145
Copper	
Wire	220
Firebox, cut up	217
Heavy	215
Light	212
Cuttings	223
Turnings	195
Braziery	186

Gunmetal	£
Gear Wheels	210
Admiralty	210
Commercial	194
Turnings	189
Lead	
Scrap	58
Nickel	
Cuttings	—
Anodes	530
Phosphor Bronze	
Scrap	194
Turnings	189
Zinc	
Remelted	76
Cuttings	66
Old Zinc	46

Financial News

Metal Agencies Company

Net profit year ended February 28, 1961, £284,874 (£247,690), and second interim dividend, under terms of proposed merger with William Dibben and Sons, of 15 per cent. Fixed assets £1,193,621 (£1,160,765), current assets £2,385,425 (£2,163,279), and liabilities £880,652 (£775,706). Outstanding commitments £60,000 (nil).

British Pressure Diecasting

Profit for year ended October 31, 1960, of company's wholly-owned subsidiary, British Die Casting and Engineering Co., was £75,204, before tax.

W. Williams and Sons (Holdings)

Group net profit, year to December 25, 1960, £63,296 (£47,431) and dividend 15 per cent (13 per cent). Fixed assets £222,317 (£194,995), current assets £492,723 (£425,720) and liabilities £241,336 (£211,372).

Hawker Marris

Dividend for 1960 is 3s. 6d. per £1 share (same). Group profit £33,212 (£31,274). Net profit £16,934 (£17,063), after tax £16,278 (£14,211). To general reserve £10,000 (same), forward £36,824 (£36,225). Net current assets £103,705 (£115,430).

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Ipsen Industries Limited (689168), 53 Victoria Road, Surbiton, Surrey. Registered April 10, 1961. To carry on business of manufacturers of and dealers in heat-treating furnaces, etc. Nominal capital, £100 in £1 shares. Directors: Harold Ipsen, Mrs. Lorraine Ipsen, Cornelius Luiten and Thomas Ruffle.

J. Whelan and Sons Castings (Enfield) Limited (689266), 1a South Road, N.11. Registered April 10, 1961. Nominal capital, £100 in £1 shares. Directors: John J. Whelan and Mrs. Doris A. Whelan.

Covered Structures Limited (689334), Gordon Road, Lea Road, Waltham Abbey, Essex. Registered April 11, 1961. To carry on business of builders of metal constructions, etc. Nominal capital, £1,000 in £1 shares. Directors: Lauri Gerrish and Mrs. W. C. Gerrish.

M. and M. Industrial Metal Co. (Farnborough) Limited (689420), 1 Bruce Avenue, Shepperton. Registered April 11, 1961. Nominal capital, £1,000 in £1 shares. Directors: Florence Altass and Naomi Cotton.

Tilson Metal Fabrications Limited (689521), 3 Avondale Close, Hersham, Surrey. Registered April 11, 1961. Nominal capital, £1,000 in £1 shares. Directors: Mrs. Sheila B. Stow and Edward H. V. Tilson.

Walthamstow Scrap Metal Limited (689523), 83-5 St. Mary Road, E.17. Registered April 11, 1961. Nominal capital, £100 in £1 shares. Director: Henry S. Taylor.

Percy Fulcher and Company Limited (689647), Springfield Works, Spring Lane, Bury St. Edmunds. Registered April 13, 1961. To take over the business of demolition contractors and scrap metal merchants carried on at Bury St. Edmunds by P. G. W. Fulcher and J. Boyden, etc. Nominal capital, £12,000 in £1 shares. Directors: Percival G. W. Fulcher and John Boyden.

Mark Newland and Company Limited (689899), 41-5 Barton Road, St. Philips, Bristol. 2. Registered April 17, 1961. To carry on business of scrap metal merchants, etc. Nominal capital, £500 in £1 shares. Directors: Wm. D. F. R. Newland, Mrs. Irene R. Newland and John Coats.

Silbond Refractories Limited (960060), 20 Crofton Avenue, Sheffield, 6. Registered April 18, 1961. To take over the business of "Silbond Refractory Manufacturing Co." carried on at Crofton Avenue and Claywheels Lane, both in Sheffield, etc. Nominal capital, £20,000 in £1 shares. Permanent directors: John B. Denton and James Cox.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

France (new francs per kilo):

Electrolytic copper scrap	(£223.3.0)	3.02
Heavy copper	(£223.3.0)	3.02
No. 1 copper wire	(£209.2.0)	2.83
Brass rod ends	(£169.19.0)	2.30
Zinc castings	(£71.13.0)	0.97
Lead	(£66.10.0)	0.90
Aluminium	(£125.12.0)	1.70

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£178.2.0)	305
Lead, soft, first quality	(£80.11.0)	138
Lead, battery plates	(£45.11.0)	78
Copper, first grade	(£224.16.0)	385
Bronze, commercial gunmetal	(£198.11.0)	340
Brass, heavy	(£157.13.0)	270
Brass, light	(£146.0.0)	250
Brass, bar turnings	(£157.13.0)	270
Old zinc	(£64.4.0)	110

Japan (Yen per metric ton):

Electrolytic copper	(£—)	293,000
Copper wire No. 1	(£—)	267,000
Copper wire No. 2	(£—)	252,000
Heavy copper	(£—)	252,000
Light copper	(£—)	220,000
Brass, new cuttings	(£—)	206,000
Red brass scrap	(£—)	215,000

West Germany (D-marks per 100 kilos):

Used copper wire	(£204.19.0)	225
Heavy copper	(£204.19.0)	225
Light copper	(£182.4.0)	200
Heavy brass	(£132.1.0)	145
Light brass	(£95.13.0)	105
Soft lead scrap	(£52.16.0)	58
Zinc scrap	(£52.16.0)	58
Used aluminium unsorted	(£81.19.0)	90

Trade Publications

Welding Notes. — Suffolk Iron Foundry (1920) Limited, Stowmarket, Suffolk.

The latest issue of "Sif-Tips" contains a number of interesting articles dealing with welding techniques and also some notes on the new precision Oxy-flame cutter.

Electronic Die-Saver.—Radiovisor Parent Limited, Stanhope Works, High Path, London, S.W.19.

A leaflet describes and illustrates a new "Robotron" electronic die saver which prevents die damage by continually monitoring power press operations and making sure that the component is ejected from the die before the press is allowed to commence the next stroke.

Melting Furnaces. — Monometer Manufacturing Company Ltd., Savoy House, 115-116 Strand, London, W.C.2.

A useful three-fold leaflet, in colour, describes and illustrates the wide range of melting furnaces produced by this company. Rotary furnaces, tilting furnaces, new basin tilting furnaces for the die-casting industry, lift-out crucible furnaces, bale-out furnaces, whitemetal melting furnaces, semi-rotary furnaces, and dry hearth melting furnaces are all included in this leaflet. Melting furnaces for aluminium diecasters, and for ingot-makers are also described.

Aluminium Flooring Material. — Alcan Industries Ltd., Banbury, Oxon.

This new publication describes Noral treadplate, an aluminium flooring material with a pattern of raised lozenges, which provides a safe foothold under all conditions of use in factories, goods vehicles and ships. Full technical data is given to enable the most suitable size and alloy to be selected for any particular application. A number of illustrations are included.

Conveyor Furnaces. — Royce Electric Furnaces Ltd., Albert Drive, Sheerwater, Woking, Surrey.

In this new four-page leaflet, attention is drawn to the Royce hump-back conveyor furnaces, the "W" type for temperatures up to 1,000° C., and the "T" type for temperatures up to 1,150° C. Specifications are given, with other data and illustrations. These furnaces are stated to be particularly suitable for bright heat-treatment processes.

Tin and its Uses — The Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex.

The latest issue of this quarterly journal cites instances where additions of metallic tin to molten iron in the ladle gives much desired improvements in properties, as, for example, in clutch plates and stack castings. Waterless fluxes for soldering and tin-nickel plating are also subjects for notes.

De-Rusting Materials. — The Pyrene Company Ltd., Metal Finishing Division, Great West Road, Brentford, Middlesex.

A four-page leaflet describes several de-rusting materials provided by the company, including "Preperite", "Paste Preperite" and "Pyroclean No. 201", the latter being suitable for either removing the scale and sludge formed on heating coils, etc., in "Bonderizing" and "Parkerizing" plants and similar installations, or as a derusting solution.

THE STOCK EXCHANGE

Considerable Buying For Start of The New Account

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 8 MAY	+ RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	33/-		11	9	6 13 3	33/-	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/3	+ 3d.	NIL	4	NIL	1/3	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries ...	43/3	—3d.	15	15	6 18 9	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	72/6	+ 5/-	10	15‡	2 15 3	72/6	45/-	51/3	29/-
4,795,000	1	Birmid Industries	92/3	—12/3	20	20D	4 8 9	103/-	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	34/-	—2/-	17½QT	12½	3 8 6	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/6	+ 6d.	5	5	6 18 0	14/6	13/9	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/-	+ 3d.	6	6	7 1 3	17/6	16/9	20/-	17/1½
500,000	1	Bolton (Thos.) & Sons	57/6	+ 5/-	12½	10	4 7 0	57/6	37/6	43/-	36/-
300,000	1	Ditto Pref. 5%	16/6	+ 2/6	5	5	6 1 3	16/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	17/-		6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	62/-		13½	13½	4 7 3	62/-	50/4½	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd., Ord. ...	24/3xcap	—4½d.	16D	16	2 4 0	24/7½	17/6	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	16/10½	—7½d.	15‡	25 + *2½C‡	4 13 9	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/3	—1½d.	NIL	12½	—	1/7½	1/-	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	28/6		12	10	8 8 6	29/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	4/3		15	15	7 1 3	4/2½	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	75/-	—2/6	20	15	5 6 9	77/6	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	172/6	+ 1/3	30‡	20	1 14 9	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	27/-	+ 1/3	20	17½	3 14 0	27/-	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	46/6	—1/6	15	15	6 9 0	52/3	45/-	56/9	45/-
1,155,000	1	Evered & Co.	44/6xd		10B	10φ	3 0 0	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	36/6	+ 6d.	10	10	5 9 6	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	63/-	—6d.	25	20	3 19 3	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	20/-	—6d.	13	11½	3 5 0	21/1½	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	28/9	+ 1/3	22½	25¶	3 18 3	30/-	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries ...	40/-	—3/-	19L	16	3 11 3	44/9	34/9	41/9	33/-
696,780	10/-	Greenwood & Batley	27/9xcap	—1/3	30‡	30	5 8 3	29/6	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	14/6	+ 4½d.	*20‡	*17½	3 9 0	14/6	12/-	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	20/3	+ 3d.	7	7	6 18 3	20/3	20/-	23/6	22/-
1,612,750	5/-	Heenan Group	16/6	+ 3d.	13	15	3 18 9	17/1½	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries ...	78/9	—3d.	13½	11½	3 9 9	78/9	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/9	+ 3d.	5	5	6 7 0	15/9	14/10½	18/-	15/4½
29,196,118	**	International Nickel	150	+ 10	$1.60	$1.50	1 18 3	150	104	105	84½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/6		5	5	6 18 0	14/10½	14/-	16/6	14/6
6,000,000	1	Ditto Ord.	64/-	+ 3d.	12	12D	3 15 0	64/3	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	21/3		17½	17½E	8 4 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	14/1½	+ 4½d.	12	10	3 8 0	14/1½	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord.	63/3xd		17½F	15F	5 10 9	63/9	53/6	71/6	57/3
1,530,024	1'	Ditto A. Ord.	62/9xd	+ 9d.	17½F	15F	5 11 6	62/9	53/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	16/-		20‡	20‡	6 10 0	18/6	14/-	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/6		7½	7½	8 3 9	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	94/-	+ 1/3	12M	13B	2 6 6	94/-	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/6		50	50	11 15 3	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	43/-	+ 2/-	12½	10	5 16 0	43/-	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3		6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A	70/6	—9d.	13	12	3 13 9	71/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	15/6		5½	5½	7 2 0	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	50/6	+ 2/3	22½J	15	5 1 9	50/6	39/9	45/-	35/3
585,000	5/-	Ratcliffs (Great Bridge) Ord. ...	16/3	+ 3d.	10	10R	3 1 6	16/6	16/-	17/-	14/9
195,000	5/-	Ditto 8% Max. Ord.	4/10½	+ 1½d.	8	—	8 4 0	5/-	4/10½	5/3	5/-
1,064,880	10/-	Sanderson Kayser	38/9	+ 1/3	35‡	25	4 10 3	38/9	33/9	40/3	27/7½
3,400,500	Stk. (5/-)	Serck	17/1½	—4½d.	12½	17½GD	3 13 0	18/3	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	63/9	—2/3	15	15	4 14 0	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/6		5½	5½	7 2 0	15/9	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	80/3xd	+ 6d.	14	20	3 9 9	85/6	72/3	140/3	63/10½
41,000,000	Stk. (£1)	Vickers	36/9	+ 9d.	10	10	5 8 9	37/3	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref. 5%	14/6		5	5	6 18 0	14/9	12/7½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6		*5	*5	7 5 0A	20/7½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	81/-	+ 6d.	13½	25	3 7 9	81/-	64/6	94/-	63/-
7,109,424	Stk. (£1)	Westinghouse Brake	43/9	+ 2/-	11	10	5 0 6	43/9	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting ...	12/7½	—4½d.	35	30	5 11 0	13/-	9/-	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	28/6		32½	27½	5 14 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/6	+ 1½d.	15	20‡	8 6 9	4/6	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	8 17 9	13/7½	13/6	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/3		40	30	7 12 6	5/6	4/6	5/4½	4/-

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. ⊕The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. R and 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units. φ and 6½% from Capital Profits B and 50% capitalized issue. G and 1½d special distribution. F and special 5% tax free dividend H As forecast ¶And 3 for 7 capitalized issue. L and 33⅓% capitalized issue. M and 10% capitalized issue. I and 75% capitalized issue. S and 40% capitalized issue. O calculated at 13½%. Interim on smaller capital P Calculated at 11⅓%. Q also 1/- special tax free dividend and 50% capitalized issue. T Per £1 unit. Calculated at 15%. Z After capital reorganization

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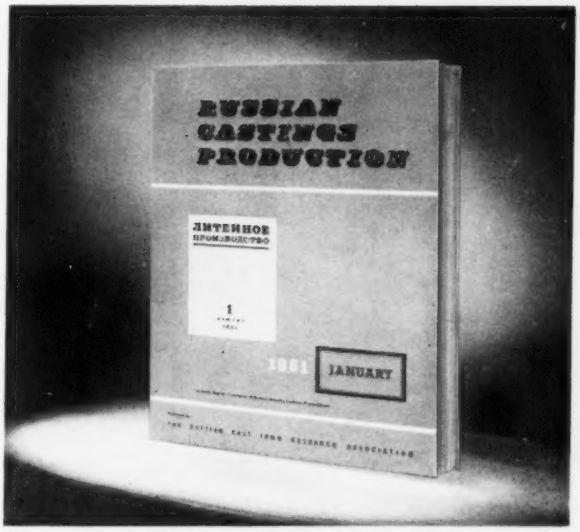

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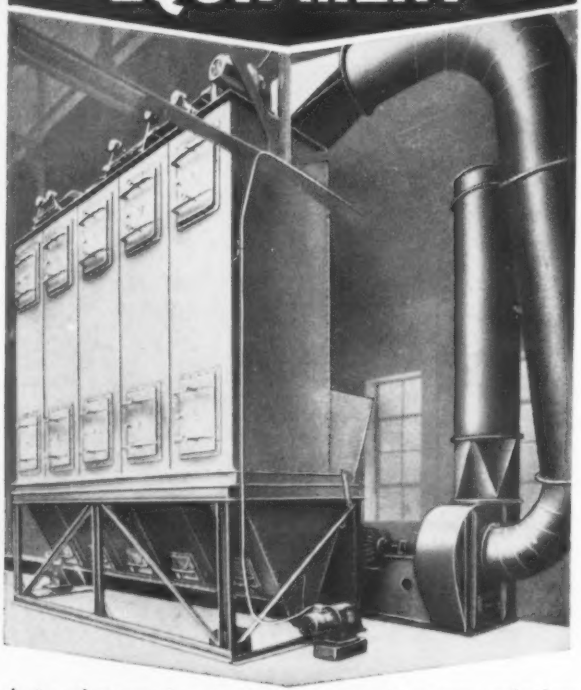

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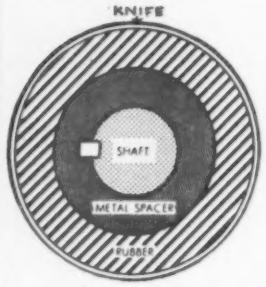

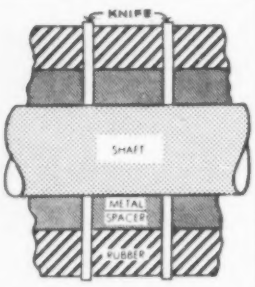

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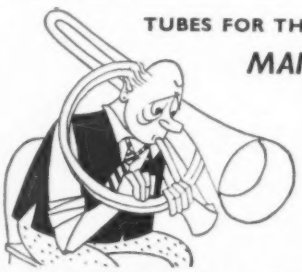

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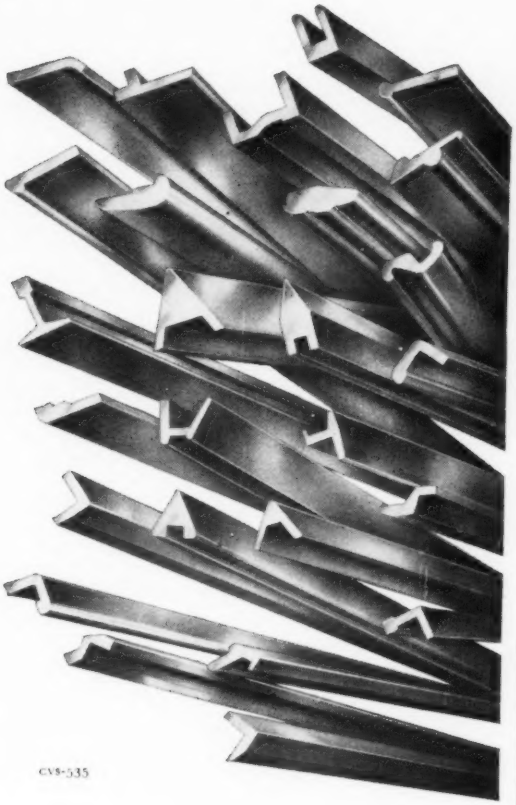

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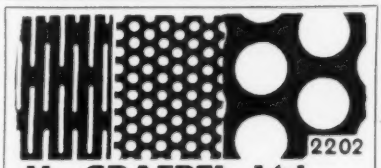

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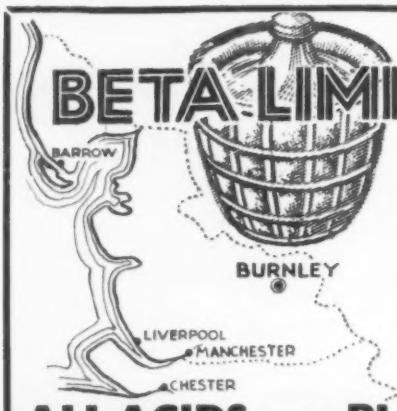

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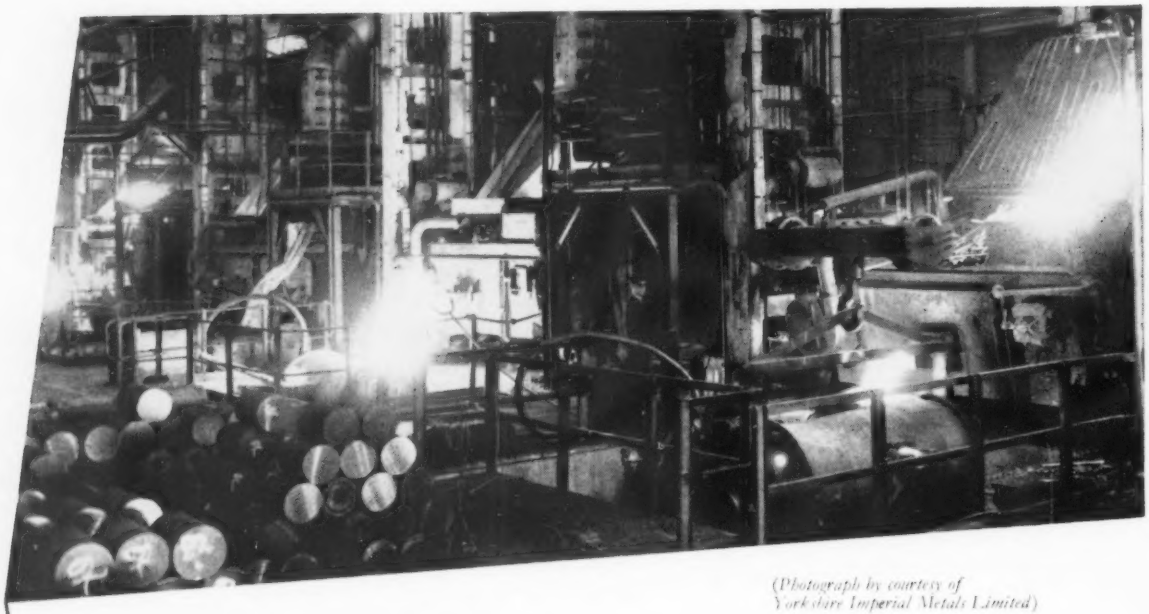

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